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# Factors Affecting Auction Market Operating Costs

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# Summary and Conclusions

AT THE TIME THE DATA for this study were collected there were 178 livestock auctions operating in Texas; 140 were included in this analysis. They ranged in size from just over 5,000 animal units per year to almost 350,000. It has been shown that operational efficiency, measured in terms of average cost per unit marketed, increases directly with firm size and that efficiency gains were most marked as output increased from low-volume levels.

Firms with annual volumes below 15,000 marketing units are inefficient and can be considered submarginal markets. Those with volumes of less than 25,000 animal units are also at a disadvantage from the standpoint of efficiency and are considered to be only marginal operations. More than 37 percent of all Texas auctions fall within these two size categories.

As volume increases from 25,000 to 40,000 animal units annually, increases in efficiency continue to be revealed but at a decreasing rate. The ability of firms in this group to operate efficiently depends largely upon the quality of management available. The most significant cost economies have been realized by the time volume has reached 40,000 units, although continuous but small increases are shown throughout the larger size ranges. For this reason, 40,000 animal units have been arbitrarily established as the minimal size goal.

An analysis of auction charges or commission rates was not included in this study; consequently, income functions and their relations to firm size were not established. However, supplemental questionnaires concerning management practices indicated that the individual firms' commission rates were competitively based and were generally similar to those at nearby markets. With the exception of one large firm, there was apparently no tendency for commission rates to be lower at high volume markets than at small ones. Major rate variations were found to be intra-firm in character, a result of sliding rate scales that granted lower rates on large consignments. To the extent that the larger firms handled a greater proportion of large consignments, this practice may result in a slightly lower average revenue per animal unit for the larger firms. However, the average revenue curve is assumed to be both linear and almost horizontal with respect to firm size.

Under competitive market conditions involving a steeply sloping cost curve at low output levels combined with a horizontal revenue curve, the smaller markets may be assumed to be operating at a loss. These high cost firms will be forced out of the market in the long run. Because of the specialized nature of auction facilities and the tendency toward asset fixity, the transition may take many years. Small inefficient

auctions can continue to operate so long as their revenue exceeds their variable costs. Only as facilities wear out and need replacement will they be forced out of business by the larger, more efficient operations. Even then, the auctions may be refinanced and begin operation again under new ownership. This cycle has been repeated two or more times by a number of Texas auctions and may be repeated as long as sufficient risk capital is available and civic pressure is exerted for a livestock auction in the community.

The continuing large number of high cost, inefficient small-volume firms is evidence of considerable overinvestment in livestock auction markets. This overinvestment in plant, equipment, labor and associated marketing expenses results in a much higher social cost of auction operations than would exist with fewer firms having higher volumes and lower unit costs.

This problem of overinvestment—which resolves itself to the problem of too many small firms—may be attacked in one of two ways. Either the volumes handled by small firms may be increased substantially, or the number of firms may be reduced.

If all Texas auctions are to continue in operation and if acceptable levels of efficiency are to be attained, the need for increasing the volume of livestock handled at small auctions is essential. Volume at a specific market may be increased in only three ways: by taking volume away from a competing auction, by diverting volume from a competing marketing system such as terminal markets or direct selling or by increasing the quantity of livestock marketed and retaining a proportionate share of the total.

If one auction diverts volume from another, the total auction volume will be unchanged, and volume-induced gains in efficiency at the first market will tend to be offset by losses at the second. Given the present structure of the industry, it is likely that competing markets will be of somewhat comparable sizes, and the net gains in efficiency would be negligible. Except for isolated instances, the prospect of increasing volume at a small market by taking trade from a large one does not appear practical.

A large part of the increase in auction volume during the period of most rapid auction growth came from diversions from terminal markets. Terminals have now been reduced to such low volumes that substantial additional gains cannot be anticipated from that source. Direct marketing, on the other hand, remains highly competitive with auctions. Packers continue to pursue an aggressive direct buying program, and the larger feedlot operators buy substantial volumes directly from producers. Unless this trend is reversed, the auctions may lose volume to direct buyers rather than gain from them.

Historically, livestock production has increased in this country, and a large part of this increase in recent years has been among the types of producers that use auction facilities most. The rapid growth of livestock production among small integrated farm operations has provided a large part of the increased volume handled by auctions since World War II. Most recent census data indicate that the trend to smaller average-size farms has been reversed and that farm size is increasing. If this trend continues, it may tend to offset the counter-trend of integrating livestock production with other farm enterprises. That is, as the average size of the production herd increases, more alternative marketing choices will be available to the producer. Under these conditions, auctions may do well to retain their current proportion of total marketings.

In summary, the prospect of auctions solving the efficiency problems of small markets through general increases in volume do not appear bright. Neither are there known technological innovations available that promise substantial internal cost reductions. This leads to the conclusion that, from the standpoint of operational efficiency, there are too many auctions in operation in Texas.

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# Factors Affecting Auction Market Operating Costs

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THE RAPID GROWTH of livestock auctions possibly has been carried too far, resulting in a larger than necessary number of low-volume firms with high unit costs. This oversupply of marketing facilities may be substantiated if a large number of firms with high unit costs actually exist. The fluctuation in absolute numbers of firms in operation from year to year and the high proportion of firm failures and ownership changes not revealed in these figures would lead one to suspect this condition does exist in Texas. However, little research has been conducted to establish either optimal or minimal firm size within this industry or to accurately describe the relationship existing between volume of livestock handled and unit costs.

If a positive relationship can be developed between auction size and operating unit costs, the groundwork can be laid for evaluating the adequacy of present facilities for meeting the needs of Texas producers. It also should be possible to develop from such relationships recommended minimum and optimum size levels to be used as guides in remedial action programs. Then, if it is determined that there is a large proportion of auctions operating below these minimum volumes and at high unit costs, a conclusion of the existence of excess capacity and overinvestment may be reached. Such a conclusion cannot be justified on the basis of auction numbers alone.

Overcapacity and its resulting inefficiencies are important to the public in general as well as to the operators of the markets and to livestock producers who use those facilities. In its simplest terms, overinvestment in auction facilities means that capital, labor and other economic resources are being used less productively in this enterprise than they could be used elsewhere. To this extent there is a social cost associated with overinvestment that is reflected in the welfare of the public as a whole.

The effect of overinvestment on the marginal market owner is more obvious and considerably more direct. If he cannot obtain a return on his investment equal to his opportunity cost, he suffers an economic loss. The producer, on the other hand, suffers a direct economic loss only when the auctions' high unit costs result in higher marketing charges. He may be subject to indirect losses, though, that are less noticeable but potentially greater in size. These occur when either excessively small market size or high unit costs restrict the auction in its market performance.

There also is a definite need to understand more fully the effect that various market operating practices have upon the ability of a market to perform its function completely and efficiently. Since all auction markets do not apply functional cost accounting techniques to their operations, they are not always able to rationally evaluate the economic consequences of specific practices. Neither do they have sufficient information to determine the proper ratio of costs in their daily operations. Proper cost ratio guides, however, would enable them to determine when specific costs are out of line for their scale of operation. A more complete understanding of functional costs also would permit them to evaluate better the consequences of instituting new or expanded practices in an effort to increase their volume of operation.

The purposes of this study are to develop cost-volume relationships for the various major operating cost categories as well as the relationship between average unit costs and economies of size, and to isolate and classify those institutional, physical and operational factors which affect market operations and costs. The results of this analysis will prove useful in several ways.

1. Provide standards or guidelines for the use of individual auctions in internal cost evaluation for present plant and volume levels.

2. Establish a recommended minimal-optimal volume level for use as a guide in new plant construction.

3. Provide basic market cost relationships between different types of livestock handled for use in rate adjustments by the markets.

4. Provide basic economic data to be used in possible legislative or regulatory control of entry into the auction business.

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## SPECIFIC OBJECTIVES

The specific objectives of this study follow.

1. Develop a livestock marketing animal unit based on the cost of marketing each specie of livestock to replace the presently accepted production animal unit system.

2. Determine the relationship between total livestock auction operating costs and economies of size.

3. Determine the extent to which total marketing expenses vary for auctions of different sizes, in accordance with type of livestock handled, section of state and type of ownership.

4. Identify, classify and relate to type and size of operation those factors of non-price competition that may significantly affect market operations.

## SPECIAL CHARACTERISTICS OF AUCTIONS

A firm generally is considered as an institution which buys raw materials, processes or otherwise transforms them within its plant and sells the resulting product. It is faced with a set of factor costs for all inputs it uses and with a revenue function for its product. At different levels of output a firm is faced with varying production costs and subsequent income from sales. If a firm has profit maximization as one of its goals, it should erect the scale of plant and operate at the production level which provide the greatest divergence of revenue over cost consistent with the demand for its products and the supply of its inputs.

Livestock auctions are similar to production-oriented firms in many respects but have a number of important differences. These differences do not seriously influence the applicability of theory to auction operations; however, understanding them is essential to understanding auction response to conditions they face. The peculiarities of auction operation may be summarized as follows:

1. Auctions are providers of service rather than producers of goods in the generally accepted sense.

2. Auctions operate only on 1 or 2 specified days of the week.

3. Auctions have no control over their supply and little knowledge of what the supply will be for a particular sale until the day of the sale.

4. Auctions operate under an administered pricing system.

Many other types of firms may have one or more of these operating characteristics, but auctions probably are the only businesses that have all four. Since collectively they are peculiar to auctions, it is worthwhile to examine the individual characteristics in more detail and their economic implications in the aggregate.

### Auctions as Providers of Service

As service establishments, auctions merely serve as sales agents for the producer. They provide a set of physical facilities for the proper receiving, holding, selling and loading out of the animals they handle. They also provide all labor necessary for the efficient operation of their market, and many of them provide various auxiliary services required by either sellers or buyers.

As publicly regulated markets, auctions are responsible for all fiscal transactions between buyers and sellers. They accept the responsibility of paying the seller for his animals and collecting payment from the buyer. They are responsible also for accurately accounting for each transaction.

Since auctions are not producers of goods in the usual sense, they do not have the opportunity to exercise managerial skill in raw material procurement. They must look to internal operations for all efficiencies and to increased volume for higher levels of revenue. As public agencies they must be prepared to handle all livestock consigned to them during each sales day. Both physical facilities and variable inputs must be available in sufficient quantity to handle the largest anticipated volumes. This causes their net revenue to be extremely sensitive to fluctuations in volume.

### Single-day Operations

Most auctions operate only 1 day a week. This is a practice forced on the markets by two important considerations. First, because of the continuous nature of livestock production, there normally is a limited number of livestock to be sold within the supply area of a particular market during any 1 week. Spreading this volume over a number of market days would result in insufficient numbers at any one sale to attract buyers for all classes of livestock. Second, major buyers, particularly packer buyers and major order buyers, operate on a schedule whereby they visit a different market each day. Auctions now are so numerous that if a given market were to increase its days of operation, it would conflict with a nearby market. To attract the necessary buyer participation it would need to assure substantial livestock volumes. Under the first restriction mentioned, this would be difficult.

Although the once-a-week sale is the normal practice, it severely affects operational efficiency and leads to higher unit costs. If a plant is used only 1 day each week, it is operating at only 20 percent of its potential normal capacity based on a 5-day work week. This means that fixed costs are approximately five times as large per unit as they would be under conditions of daily operation with comparable volumes. This, of course, overstates the case somewhat, since it would be difficult for any auction to expand its operation from 1 day to 5 days per week and retain its original volume per sale.

Another view, would be to spread the volume from the weekly sale over 5 days. In this case overall capacity could be reduced to 20 percent of original, but we could not expect a proportional decrease in total fixed costs. Many of the physical facilities, such as the auction barn itself, scales, sales ring and feeder chutes, could not be effectively miniaturized. Consequently, the reduction in capacity would result in substantial reductions in fixed costs, but at a less than proportional rate.

The practice of weekly sales has a substantial effect on a firm's average fixed costs. It is likely that a discontinuous type of operation affects variable costs by preventing the development of a more highly skilled work force than is currently available to weekly operations.

### Knowledge and Control Over Supply

Livestock auctions accept for sale all livestock delivered to them on or before the day of the sale. While they attempt to increase the overall supply through various promotion and advertising programs, they cannot effectively control supply in terms of scheduling from week to week. Also, they generally have little or no advance knowledge about the supply until the day of the sale.

The economic implications of an unknown supply are fairly obvious. Since the market operator generally sells all animals delivered for sale, his natural inclination is to construct facilities sufficient to handle the maximum number of animals he anticipates receiving on any 1 day. Both weekly and seasonal fluctuations in marketings cause rather wide variations in the number handled throughout the year. Consequently, there normally is a wide disparity between the average volume handled per sale and the maximum. This means the market operates throughout most of the year with considerable excess capacity.

Excess capacity is an economic cost to the market. It causes fixed costs to be higher than they would be if the market were in a position to regulate supply.

The lack of prior knowledge of supply also may cause increases in cost. Labor is the largest single variable cost to the market. Before the day of the sale the auction operator must arrange for a labor force to handle the anticipated volume. In the absence of precise knowledge, he may contract for either more or fewer employees than necessary. In either case the resulting labor cost per unit will be greater than optimum.

### Administered Pricing

All livestock auctions now operate under the rules and regulations of the Packers and Stockyards Act. They are required to post a schedule of charges for all services performed at the market. Any changes in the schedule of charges must be filed in writing with the U. S. Department of Agriculture, and the new charges may not take effect until at least 10 days after they have been received in Washington, D. C.

While the individual market may have considerable latitude in establishing its original pricing schedule, once the schedule is established it is inflexible over the short run. The market, then, is not able to vary the price of its services to optimize net income during any one sales period. Consequently, gross income will tend to vary directly with volume, while net income will vary directly with volume subject to the additional internal efficiency constraint.

### Aggregate Implications

These characteristics may not be overwhelming problems when considered individually. However, when taken in combination more severe implications are immediately apparent. For example, a firm that operates only 1 day a week would be in a stronger position to control unit costs if it were able to control supply. Furthermore, if it were a goods-producing firm, it could plan for severe variations in supply by developing storage capacity so that excesses and shortages could be incorporated into a smooth production program. And if it were operating under discretionary pricing, it could use price as a stimulant to either supply or demand.

Within the existing framework, however, the auction is severely limited in its alternatives. The practice of weekly sales causes overcapacity in facilities which have practically no economic alternative use during non-sale days. The lack of knowledge and control of supply adds to the overcapacity problem and prevents efficient scheduling. The fact that it is a service organization leads the market toward accepting unknown and variable supply as a standard practice and limits its ability to cope effectively with supply variation by limiting the variable inputs under management control. Finally, the lack of control over pricing in the short run prevents the market from varying its charges to optimize revenue—even if it were otherwise in a position to do so.

## METHOD AND SOURCES OF DATA

### Method

Analysis of firm costs may be undertaken in different ways. The most efficient method depends upon the specific objectives of the study and the resources available for the research. Two commonly accepted methods are the "synthetic method" and the "accounting record method". Both will be described briefly, and their major advantages developed for evaluation of potential usefulness in this study.

#### *Synthetic Method*

The synthetic method of cost analysis is an outgrowth of methodology long in use in industrial engineering. It is based upon the assumption that plants operate not as a continuous functional process but in a series of separate operations or stages. It further

assumes that each of these stages may be identified and analyzed separately as "building blocks" in the overall analysis.

In constructing these building blocks, detailed studies are necessary to develop estimates of efficiency that can be used as optimums in the aggregate analysis. Studies of this type generally require relatively large and expensive research inputs.

The major advantages of this type study are the precision with which individual cost functions may be identified and estimated and the accuracy with which absolute minimum costs may be approached. This method permits more accurate research determination of the economies-of-size curve than any other method. It also yields more accurate estimates of differences between costs of particular alternative practices.

The major disadvantages, including higher cost, outweigh the advantages for this study. This method takes the most efficient stage of operation from all the plants studied and combines them to derive a most efficient aggregate system. There is no assurance that any plant could operate at the efficiency level of the synthesized plant. Consequently, the synthetic method provides an optimum goal of "what could be" rather than a description of what is demonstratably feasible.

*Accounting Records Method*

The accounting records method of cost analysis employs as its basic tool the accounting records of individual firms. It can, therefore, produce results with relatively small research cost and has the added appeal of reflecting "real" plant operations. Furthermore, the results of these studies can be subjected to statistical tests of reliability, and their usefulness may be evaluated accordingly.

This method generally is used when broad objectives are undertaken; that is, when the major concern is an overall relationship such as that between unit cost and volume. It is not particularly useful in the evaluation of alternative operations for a particular stage, nor is it appropriate for studies comparing the relative efficiency of alternative technologies. Since this study is concerned with the broad relationships rather than with internal stage evaluations, this limitation is not serious.

However, other limitations must be recognized. Since the costs of individual firms are treated as independent observations, the researcher must assume that each plant is operating efficiently at its revealed volume of production. Any cross-section of costs for particular firms must "catch" many firms in some sort of maladjustment which, in many cases, may not be explained by the usual correlation approach. Some firms actually may be operating at insufficient volumes for their scale of plant. Other firms, because of poor management, may be operating inefficiently with proper plant-volume relationships, while still others may be caught in short run transition as they are adjusting to changed volume levels.

Regardless of the firm's actual position on either its short-run cost curve or its long-run planning curve, the researcher must assume that its records reveal the best available estimate of unit cost associated with operations at that volume. Recognition of the variation that may exist then will permit more realistic interpretation of the relationships described.

To adopt this method for study, the following assumptions must be made, subject to the recognized limitations.

1. All auctions have uniform managerial ability.

2. Variability in the assignment of costs to fixed or variable categories is assumed to be independent of market size.

3. The relative efficiency and use of alternative technologies or methods of operation are assumed to be either equal or vary independently with firm size.

These three assumptions establish the general parameters and lead to a more restrictive assumption that must apply to the long-run cost curve derived from regression analysis.

4. Each firm is assumed to be operating at the minimum unit cost point on its short-run average cost curve. However, this condition may be relaxed somewhat to admit equal variation above the minimum cost point. In that case, a fifth assumption is necessary to more accurately place the long-run cost curve.

5. The true long-run economies-of-scale curve must be below the lowest cost points observed from the sample auctions.

Since this study is intended to describe the broad relationship between operating costs and volume of livestock handled, the fact that these assumptions do not conform to conditions known to exist in the industry does not seriously impair the objectives. The assumptions merely spell out conditions that would need to exist if the relationships found were to be considered precise. They also point up the dangers of accepting the derived curves as exact truths and provide a framework for explaining the variations that will occur.

## Data Generation

The basic source of data for this study was the annual reports of Texas livestock auctions for 1962. Each auction in the state is required to submit a report each year to the regional office of the Packers and Stockyards Division of the USDA. Permission was granted by the Packers and Stockyards Division to obtain pertinent information from these reports for this study.

An effort was made to obtain records from each of the 178 auctions licensed to operate in Texas during 1962. However, a number of markets went out of business during the year and did not complete their reports. Others that began operations during the year had incomplete data for the full year. Records

of a third group, who had filed petitions for rate increases, had been sent with petitions to Washington, D. C. and were not available. A smaller fourth group had either obvious inconsistencies in their reports or had significant omissions that limited their usefulness. When all of these were eliminated, usable records were available for 140 livestock auctions. These were included in the study.

The auction annual report contains a relatively complete account of the market's operations during the year. Included are a record of the livestock volume handled by specie, an accounting of income by source and a record of market support activities. More important, however, is a detailed distribution of costs into a large number of cost categories. This made it possible to classify costs into major categories of variable and fixed costs with some degree of precision.

In addition to these records, supplementary data on management practices and areas of nonprice competition were obtained by mail questionnaire. Each of the 140 firms was sent an original schedule in March 1965. This was followed 2 weeks later by a second mailing. A total of 70 usable returns was received.

## DETERMINATION OF A MARKETING ANIMAL UNIT

Since livestock auction markets vary widely in the mix of livestock of each specie handled, it is necessary to use some measure to convert each specie to a common base. In many studies, the lack of a more precisely determined and functionally realistic measure has forced researchers into using the commonly accepted production animal unit. This measure considers an animal unit equivalent to one cow, two hogs or five sheep or goats and is based upon the nutritional requirements for physiological maintenance. It is erroneous to assume, however, that the costs involved in marketing animals of different species will vary in exact proportion to their nutritional requirements. Consequently, it was considered desirable to derive a marketing animal unit that would be applicable specifically to livestock auction markets within Texas.

Livestock auctions are purely service organizations with no production functions in the accepted sense. It appears logical that the conversion of different species to a common marketing animal unit base should depend upon the relative cost incurred by auctions in handling each specie. The records available to this study, however, did not attempt to allocate costs by specie; costs were reported on an annual basis for a variety of cost categories. The problem became one of deriving a rational distribution of costs between species for all markets.

The extent to which the ratio of costs coincides with the ratio of charges would depend upon the individual markets' ability to recognize costs and adjust its schedule of charges accordingly. Institutional factors in ratemaking which lead to small variations in charges between adjacent markets lead one to believe that the relationship between costs and charges would not be precise.

The most promising approach appeared to be to develop a ratio of coefficients from a multiple regression analysis with the number of livestock of each specie as independent variables and cost as the dependent variable. The resulting coefficients then would provide a reliable indication of the cost associated with handling single units of each specie at the volume levels in effect at Texas auction markets. A ratio of coefficients would in turn provide a measure of the relative cost for each specie, or a "marketing animal unit."

In selecting the appropriate model to be used, several decisions were necessary, some of which involved the construction of secondary or test models. First, it was necessary to reach a decision on the inclusion of horses in the analysis. The number of horses marketed through Texas auctions is relatively insignificant, and markets do not provide special facilities for handling horses. In fact, most markets that handle horses consider them a nuisance and accept them only as a service to regular customers. Consequently, it was decided to omit horses from the optimum model and ignore them throughout the analysis. This decision was tested by using a multiple regression model, which included horses as an independent variable, programmed to reject the least significant variable at the .05 level of significance. Horses were consistently rejected and, on the basis of their low simple correlation with cost, may be considered as contributing indiscriminately to the cost of market operations.

It was further decided that since the majority of Texas auctions handle all three species of livestock, the cost ratio should be based upon the experiences of only those markets. Specialized markets could have had specialized equipment or facility arrangements that would permit economies of operation not available to markets that operated multi-specie plants. Within the available data, 92 of the 140 markets handled all three types of livestock. These were selected as the subject firms for this analysis.

Finally, two measures of cost were available, either of which could have been used as the dependent variable. These were total variable cost, defined as the sum of all cost categories which vary directly with volume, and total cost, which adds to variable cost all remaining cost items considered fixed with respect to volume. Logical consistency dictated that both measures be included in the analysis and that, while the absolute magnitude of the coefficients would be expected to vary, the ratio should remain fairly stable. Because of potential reporting discrepancies in fixed cost items, however, it was anticipated that variable cost would provide the most reliable relationships.

TABLE 1. ANALYSIS OF VARIANCE OF MULTIPLE REGRESSION MODEL 1

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| | | (000,000) | (000,000) | |
| Total | 91 | 107,946 | | |
| Due to regression | 3 | 91,312 | 30,437 | 161** |
| Error | 88 | 16,634 | 189 | |

For the first regression analysis, then, the multiple linear regression form $Y = A + b_1X_1 + b_2X_2 + b_3X_3$ was used, where

$Y$ = total variable cost per auction,
$X_1$ = number of cattle and calves handled,
$X_2$ = number of hogs handled,
$X_3$ = number of sheep and goats handled.

Data from 92 markets were used as inputs with the resulting multiple regression equation:

(Model 1)

$$Y = 4{,}030 + 1.07X_1 + 1.08X_2 + .18X_3$$
$$R^2 = .85$$

The regression statement says, in effect, that within this range of observations, an increase of one unit in the number of cattle marketed would increase variable costs $1.07. Similarly, one hog would increase costs $1.08, and one sheep or goat would add 18 cents. The Y intercept of 4,030 deserves an explanation, since logically true variable costs should be zero when no animals are handled. However, a sizable amount shows up for two reasons: a certain amount of variable cost is necessary to permit the market to function at all, and the accounting system used lacks the precision necessary to completely identify and isolate all variable costs. The intercept value should, therefore, be loosely interpreted as a combination minimum variable cost for any operation and an accounting error term.

The $R^2$ of .85 indicates that 85 percent of the variation in variable cost is accounted for by the three independent variables. The statistical significance of the regression is shown in the analysis of variance, Table 1.

The reduction in sum of squares attributable to regression can be tested for significance by use of the "F" test. In this case the regression is statistically significant at the .01 level of probability.

Since the Y intercept is a partial error term, it was decided to develop an intermediate model by

TABLE 2. ANALYSIS OF VARIANCE OF MULTIPLE REGRESSION MODEL 2

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| | | (000,000) | (000,000) | |
| Total | 92 | 312,225 | | |
| Due to regression | 3 | 295,140 | 98,380 | 513** |
| Error | 89 | 17,084 | 191 | |

TABLE 3. STEP-UP ANALYSIS OF VARIANCE (SUMMARY) OF MULTIPLE REGRESSION MODEL 3

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| | | (000,000) | (000,000) | |
| Total | 91 | 320,523 | | |
| Due to regression of variables $X_1$, $X_2$, $X_3$ | 3 | 262,939 | 87,646 | 133** |
| Error | 88 | 57,584 | 654 | |
| Due to $X_4$ | 1 | 12 | 12 | .016 N.S. |
| Error | 69 | 51,252 | 742 | |

rerunning this same basic analysis with the A term deleted. This would eliminate the Y intercept by forcing the regression line through the origin. The regression then would measure variations from zero rather than from the mean, and a higher $R^2$ and a somewhat larger mean square error could be expected.

Using the model $Y = b_1X_1 + b_2X_2 + b_3X_3$, the following regression equation was developed:

(Model 2)

$$Y = 1.15X_1 + 1.21X_2 + .18X_3$$
$$R^2 = .95$$

In the analysis of variance, Table 2, the regression again was highly significant, while the mean square error was only slightly increased.

The third model, used principally as a reliability check, substituted total costs for variable cost as the Y terms of Model 1. This yielded the regression equation:

(Model 3)

$$Y = 1.688 + 1.81X_1 + 1.91X_2 + .31X_3$$
$$R^2 = .82$$

Horses were included as the $X_4$ variable in the original run of this model, with the program set to reject the least significant variable at the $t_{.05}$ level. Both the simple correlation value ($X_4$ and total cost = .0109) and the standard partial regression coefficient ($X_4$ = .0083) were extremely low. The variable was rejected, and the results of the tests of significance for both the significant variables and the rejected one are shown in the summary analysis of variance, Table 3.

From each of the three models was derived a set of coefficients, with those from Model 1 serving as the anticipated standard and those from Models 2 and 3 as corroborative checks.

The coefficients vary in magnitude because they are measuring slightly different things. However, it

TABLE 4. COEFFICIENTS DEVELOPED FROM THREE MULTIPLE REGRESSION MODELS

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| $X_1$ (cattle) | 1.07 | 1.15 | 1.80 |
| $X_2$ (hogs) | 1.08 | 1.21 | 1.91 |
| $X_3$ (sheep) | .18 | .18 | .30 |

is the relationships between the coefficients rather than their actual values that is of primary interest, since it is from the relationships that the ratios or index numbers will be developed.

By converting the coefficients to index numbers, Table 5, the primary relationship is developed. By letting one head of cattle equal one marketing animal unit, a base is obtained from which the other species can be converted in accordance with their relative cost based values.

On the basis of the relative cost incurred by the market in its handling, a marketing animal unit should be equated to approximately one head of cattle, one hog or six sheep. This rounded ratio is substantiated by all three models tested.

The relationship between cattle and hogs, which is probably the most critical one in the analysis and the one that departs furtherest from generally used ratios, is substantiated by time studies previously conducted on Texas auctions. In these studies it was found that the time required to sell hogs in single units was the same as that required for cattle. While some time savings were shown when comparative group sizes increased to five animals per lot, these savings were offset in the aggregate by the lower incidence of larger group sales of hogs.

## INSTITUTIONAL ENVIRONMENT

There are a number of institutional factors important to auction operations. These may be cost-influencing in varying degrees. An understanding of some of these factors is necessary to provide a foundation for the analysis of plant costs.

### Number and Location of Auctions

There were 178 livestock auction markets in Texas during 1964, Figure 1. Markets are now well distributed throughout most of the state. The first auctions were located only in major livestock producing areas and in nonterminal market cities with extensive trade territories. As the number of markets expanded, less desirable new locations were taken, and many of the better ones soon had two or more auctions.

An earlier Texas study found livestock density to be an important factor in auction location. Areas of the state having less than 20 animal units per square mile had proportionately fewer auction markets than more heavily populated regions. As livestock density increased above 40 animal units per square mile, however, auction density (measured in square miles per

TABLE 5. INDEX OF COEFFICIENTS DEVELOPED FROM THREE MULTIPLE REGRESSION MODELS (CATTLE = 1.00)

| Variable | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Cattle | 1.00 | 1.00 | 1.00 |
| Hogs | .99 | .95 | .94 |
| Sheep | 5.94 | 6.38 | 6.00 |

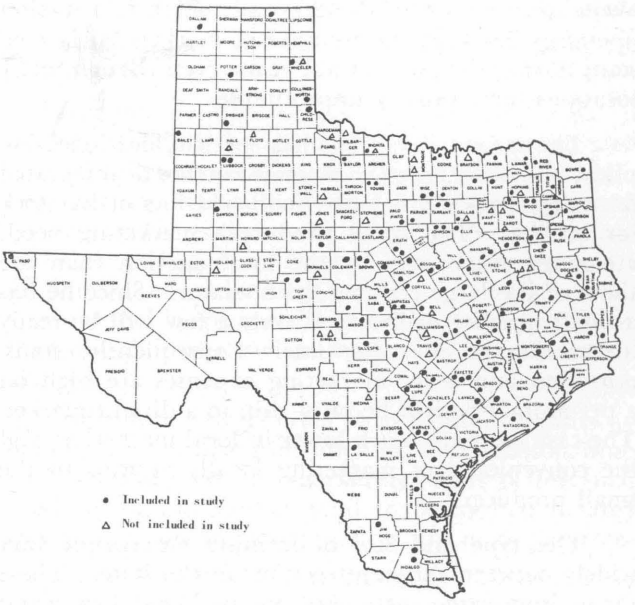


Figure 1. Location of livestock auctions, January 1, 1964.

auction) remained fairly constant. Other factors are important in determining the number of markets that would be located within a particular area of the state or local community. The relationship between livestock density and auction location will be discussed later.

The general forces giving rise to auction growth and development have been discussed. However, two of these factors may be equally important in determining specific location. One of the primary determinants of whether a livestock market will be located in a town or community is pressure from local business and community leaders. In smaller communities particularly, an auction is considered to have an economic influence well beyond its contribution to the general sales base.

An auction market draws business to a community. Receipts from the sale of livestock are often banked and spent in the community where the auction is located. A multiplier effect from the primary source of income results in continued transfer of money within a community, giving a greater impact upon the economic activity than just the initial amount of money introduced into the community.

This anticipation of economic side benefits has caused many auctions to be started in areas already adequately served by facilities in nearby communities. Also it probably has been responsible for auctions being established in areas that do not have potential marketing volumes to support adequately a market of efficient size.

There appears to be adequate speculative capital available to establish markets in even the fringe areas of potential profitability. Many of these markets must be refinanced one or more times as the original owners find they cannot be operated profitably. The ready

availability of both capital and potential auction operators has kept the number of markets fairly constant during the past several years, even though many locations have proven unprofitable.

The second force that has specific locational implications is the number of small ranches or integrated farm enterprises with only small odd lots of livestock for market. The small producer's marketing needs are more nearly met by the local auction than are those of the large commercial operator. Since he has a small number of livestock, only a few will be ready for market at any one time. Consequently, transportation and other marketing expenses are high on a per animal basis if he must ship to a distant market. The cash costs are much lower in local marketing, and the convenience of marketing locally appeals to the small producer.

The type and size of farming enterprises vary widely between different sections of the state. These range from large cattle ranches in West Texas and extensive sheep operations in the western Edwards Plateau to small stock and row crop farms in eastern areas. The latter trade most heavily through livestock auctions and are the major source of auction volume.

### Distribution by Areas

It would be impossible to divide the state into any reasonable number of completely homogeneous livestock production and marketing areas. To differentiate some of the major variations, the state has been arbitrarily divided into the five regions shown in Figure 2. These divisions were made on the basis of livestock density, type of farming enterprises, type of livestock production practices and geographical and climatic differences.

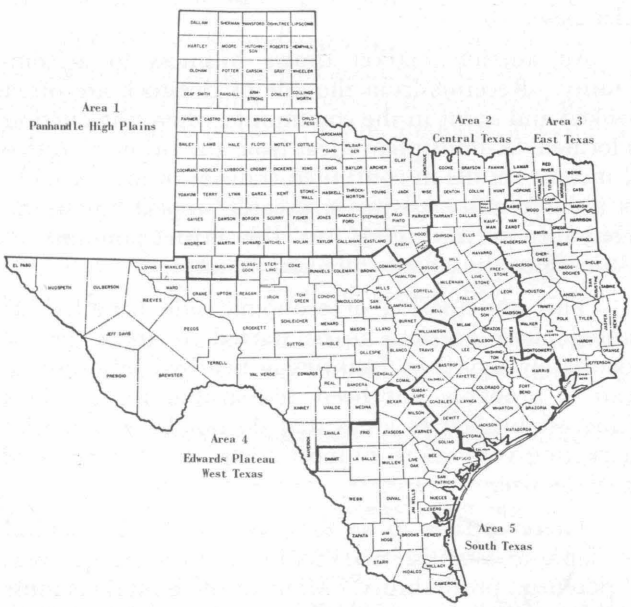


**Figure 2. Auction areas based on livestock density, type of production and geographic characteristics.**

Area 1, which includes the Panhandle and High Plains, is characterized by extensive cattle grazing operations and large scale farming operations. Sizes of cattle herds are generally large. This area includes the major wheat producing counties of the state, and winter grazing on wheat fields is a part of the general cattle production enterprise. Neither dairying nor sheep and goat production is common, although a few sheep ranches are located in the southern edge of the area.

Area 2 extends through the east-central section of the state and is characterized by a more intensive livestock production system. This is largely a farming area that recently has gone through the transition from row crops, particularly cotton, to a more integrated farm-livestock economy. Cattle herds are generally small, and dairying is common. This area has a greater density of beef cattle, dairy cattle and hogs than any other section.

Area 3 includes the most heavily timbered areas of East Texas. Farming enterprises are similar to Area 2, but the total livestock density is considerably less. Again, livestock production generally is carried on in small units and usually in connection with other farming enterprises.

In contrast, Area 4, the Edwards Plateau-West Texas area, has an altogether different type of production. The most western part consists almost entirely of large ranches with little farming. Both sheep and cattle are produced in large ownerships over wide expanses of land. In the eastern part, smaller combination ranches are found with cattle, sheep and goats on the same ranch. This means smaller units of any one specie and makes this system of livestock production better oriented to auction marketing. The concentration of auctions in the eastern edge of the region is quite noticeable. There are few dairy cattle or hogs grown in this area.

Area 5, South Texas, is largely a dry, brushy area with extensive livetock production enterprises. There are few sheep and a sparse population of dairy cattle. The area has a number of large ranches, although there are also some intensive farming areas particularly in the lower Rio Grande Valley. Throughout most of the area, livestock production is not integrated into the general farming operations.

The influence of livestock density on auction location is pointed up in Table 6. Area 2, with over 80 animal units per square mile, has the heaviest concentration of livestock of any section. It also has the largest number of auctions and one of the heaviest concentrations of auctions as reflected in the small number of square miles per auction. Area 3 has almost 50 animal units per square mile and the second largest number of auctions. It is also the most densely covered with auctions, averaging only 774 square miles per market.

TABLE 6. NUMBER OF AUCTIONS AND LIVESTOCK DENSITY BY AREA IN MARKETING ANIMAL UNITS BY SPECIE

| Characteristic | Area 1 | Area 2 | Area 3 | Area 4 | Area 5 |
|---|---|---|---|---|---|
| Square miles | 75,360 | 40,399 | 31,729 | 85,418 | 29,938 |
| Total auctions[1] | 39 | 51 | 41 | 33 | 15 |
| Livestock density[2] | | | | | |
| Beef cattle | 29.81 | 63.89 | 40.75 | 15.72 | 35.52 |
| Dairy cattle | 1.11 | 4.52 | 3.58 | .71 | 1.77 |
| Hogs | 3.82 | 10.25 | 5.06 | 1.99 | 4.21 |
| Sheep | .86 | .99 | .11 | 10.44 | .22 |
| Goats | .91 | .36 | .25 | 4.82 | .33 |
| Total | 36.51 | 80.01 | 49.75 | 33.68 | 42.05 |
| Square miles per auction | 1,932 | 792 | 774 | 2,588 | 1,996 |
| Animal units per auction | 70,579 | 63,369 | 38,508 | 87,183 | 83,946 |

[1]Includes the remaining 38 auctions which were not otherwise included in this study.
[2]Livestock density is based on the number of livestock on farms as of the 1959 Census of Agriculture and is computed as the number of livestock per square mile.

Both of these areas have integrated farm-livestock operations with high concentrations of dairy herds and hogs—characteristics favorable for the auction method of marketing. On the basis of density alone, one would expect Area 2 to have a higher concentration of auctions. The fact that it does not is explained partially by the larger size of livestock herds in that area. Another factor is the higher proportion of calves sold locally as stockers in East Texas. This means an animal may be sold first as a stocker and resold a few months later as a feeder or butcher calf. This practice, while common in both areas, is considered to be more prevalent in East Texas. In addition, Area 3 producers are further from the Fort Worth and Houston Terminal Markets. The combination of distance from alternative markets, small lots and larger stocker sales encourages a larger proportion of total marketing to move through auctions in East Texas.

The Edwards Plateau-West Texas region has the lowest livestock density and the greatest land area per market. It also has the largest number of livestock per auction of any area in the state. Producers in this area, particularly those in the western portion, operate large ranches and generally market their livestock directly without benefit of either auction or terminal market facilities. The larger sheep operations use both local commission buyers and order buyers in addition to selling directly to feedlots and packers. These production and marketing practices have severely restricted auction location in the western portion of the state.

Auction density is approximately the same in Areas 1 and 5, although census data show that there is a greater concentration of livestock in South Texas. However, the Panhandle-High Plains area has seasonal movements of cattle to the wheat fields each winter and then out again at the end of the grazing season. A portion of this turnover moves through local auctions and keeps auction numbers somewhat higher than would be expected on the basis of on-farm density alone.

Therefore, factors other than livestock density are important in determining auction concentration. Since auctions best serve the marketing needs of the small producer or buyer, they tend to be located in areas where these production practices are most prevalent.

Table 7 shows the distribution of the 140 auctions included in this study. It also shows the distribution of each specie by areas. Among the most significant relationships are the confirmation of the relative importance of cattle marketing in Area 1 and the concentration of hog marketings in Area 2 and to a lesser degree in Area 3. Most striking, however, is the extreme concentration of sheep marketings in Area 4. More than 95 percent of the total sheep sales take place in this one area. And, although sheep account for less than 6 percent of total auction volume for the state, they make up more than 30 percent of total volume in this area.

### Auction Size

Auction volume, measured in total animal units marketed during the year, varies widely among Texas markets. The relationship between market size and unit cost will be treated in detail later, since volume is considered the major cost influencing factor.

Of the firms included in this study, volume of sales ranged from a low of 5,300 marketing animal units to almost 350,000. Table 8 shows the distribution of firms in 5,000 animal unit frequency intervals. The largest single concentration is between 10,000 and 15,000. The concentration of firms remains fairly high, however, throughout the range 10-45,000 and then declines sharply. More than half the firms handled fewer than 35,000 animal units each, and 75

TABLE 7. DISTRIBUTION OF AUCTIONS AND VOLUME OF MARKETINGS, IN MARKETING ANIMAL UNITS, BY AREAS

| Area[1] | Firms | | Cattle | | Hogs | | Sheep | | Total marketing animal units | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 1 | 26 | 18.6 | 1,197,780 | 25.1 | 31,004 | 6.5 | 4,857 | 1.6 | 1,233,641 | 22.3 |
| 2 | 44 | 31.4 | 1,598,665 | 33.6 | 224,382 | 47.2 | 4,650 | 1.6 | 1,827,697 | 33.0 |
| 3 | 31 | 22.1 | 912,264 | 19.1 | 114,867 | 24.1 | 920 | 0.3 | 1,028,051 | 18.6 |
| 4 | 26 | 18.6 | 593,448 | 12.5 | 48,529 | 10.2 | 281,875 | 95.1 | 923,852 | 16.7 |
| 5 | 13 | 9.3 | 462,428 | 9.7 | 56,988 | 12.0 | 3,997 | 1.4 | 523,413 | 9.4 |
| Total | 140 | 100.0 | 4,764,585 | 100.0 | 475,770 | 100.0 | 296,299 | 100.0 | 5,536,654 | 100.0 |

[1]Areas are shown in Figure 2.

TABLE 8. FREQUENCY DISTRIBUTION OF AUCTIONS BY VOLUME OF MARKETING ANIMAL UNITS HANDLED

| Class interval | Frequency | Percentage distribution | Cumulative percentage distribution |
|---|---|---|---|
| | Number | Percent | Percent |
| 0- 4,999 | 0 | 0.0 | 0.0 |
| 5,000- 9,999 | 6 | 4.3 | 4.3 |
| 10,000- 14,999 | 19 | 13.6 | 17.9 |
| 15,000- 19,999 | 17 | 12.2 | 30.1 |
| 20,000- 24,999 | 10 | 7.2 | 37.3 |
| 25,000- 29,999 | 8 | 5.7 | 43.0 |
| 30,000- 34,999 | 15 | 10.7 | 53.7 |
| 35,000- 39,999 | 16 | 11.4 | 65.1 |
| 40,000- 44,999 | 12 | 8.6 | 73.7 |
| 45,000- 49,999 | 3 | 2.1 | 75.8 |
| 50,000- 54,999 | 5 | 3.6 | 79.4 |
| 55,000- 59,999 | 9 | 6.4 | 85.8 |
| 60,000- 64,999 | 0 | 0.0 | 85.8 |
| 65,000- 69,999 | 4 | 2.9 | 88.7 |
| 70,000- 74,999 | 3 | 2.1 | 90.8 |
| 75,000- 79,999 | 3 | 2.1 | 92.9 |
| 80,000- 84,999 | 4 | 2.9 | 95.8 |
| 85,000- 89,999 | 0 | 0.0 | 95.8 |
| 90,000- 94,999 | 1 | .7 | 96.5 |
| 95,000- 99,999 | 1 | .7 | 97.2 |
| 100,000-199,999 | 2 | 1.4 | 98.6 |
| 200,000-299,999 | 1 | .7 | 99.3 |
| 300,000-Above | 1 | .7 | 100.0 |
| Total | 140 | 100.0 | 100.0 |

percent handled less than 50,000. The percentage of firms handling in excess of 100,000 animal units was extremely small.

To develop combinations of firms more suitable for analytical purposes, the 140 study firms were divided into five size groups. The smallest size group includes all markets handling less than 15,000 head annually. Auctions in this group generally are considered submarginal operations with low income and high unit costs. Size Group 2 includes those markets with 15,000-24,999 animal units annually. This group is considered marginal in terms of both unit cost and net income. Size 3, handling 25,000-39,999 animal units, contains the largest percentage of Texas markets. Net income in this size range depends largely upon individual management. Size 4, 40,000-59,999, and Size 5, 60,000 and above, are the largest Texas auctions and include those selling more than 1 day per week. Generally these are considered the most profitable auctions.

The distribution of firms within these five size groupings is shown in Table 9. Also shown is the distribution of each specie of livestock handled and the proportion of all livestock, in marketing animal units, handled by firms of various sizes. The relative importance of the larger firms in total marketings is readily apparent. More than 60 percent of the total volume is handled by the two larger size groups (sizes 4 and 5).

## Auction Type

Although most Texas auctions handle some of all three species of livestock, some markets handle only cattle or cattle and hogs. Other markets handle hogs or sheep in such small quantities that they do not provide specialized facilities for them. The figures on sheep include both sheep and goats. Auction records did not distinguish between sheep and goats as separate species for reporting purposes. Since there may be operational cost advantages in specializing in only one specie, it was decided to classify the markets by type. This also would give a better insight into the makeup of the runs and the relative importance of various kinds of markets.

Since all but one of the markets in this study handle cattle, they were considered the basic volume unit for markets of each type. The specialized cattle markets, Type 1, were those that handled cattle and fewer than 1,000 head of hogs and fewer than 2,500 head of sheep. This means that for a market operating 50 sales per year, average daily hog volume would be less than 20 and sheep volume would be under 50. Markets would not be expected to provide specialized facilities for volumes at these levels, and Type 1 auctions logically could be considered specialized cattle markets.

Type 2 markets are those that handle cattle, more than 1,000 head of hogs and fewer than 2,500 sheep. They are considered cattle-hog markets. Type 3, on the other hand, is the cattle-sheep auction. This type includes those markets with fewer than 1,000 hogs but more than 2,500 sheep. Finally, Type 4 includes the truly multi-specie auctions. Firms in this group handle more than the minimum level of all species.

The distribution of firms among the four auction types is shown in Table 10. Only one-third of the firms are specialized cattle markets, while the remainder handle above minimum levels of one or more additional specie. The largest single type is the cattle-

TABLE 9. DISTRIBUTION OF LIVESTOCK, IN MARKETING ANIMAL UNITS BY SPECIE, AMONG DIFFERENT SIZE FIRMS

| Size[1] | Firms | | Cattle | | Hogs | | Sheep | | Total marketing animal units | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 1 | 25 | 17.9 | 235,978 | 5.0 | 28,343 | 6.0 | 27,303 | 9.2 | 291,624 | 5.2 |
| 2 | 27 | 19.3 | 467,280 | 9.8 | 37,148 | 7.8 | 19,801 | 6.7 | 524,229 | 9.5 |
| 3 | 39 | 27.8 | 1,102,875 | 23.1 | 102,875 | 21.6 | 96,979 | 32.7 | 1,302,729 | 23.6 |
| 4 | 29 | 20.7 | 1,261,801 | 26.5 | 150,671 | 31.7 | 14,734 | 5.0 | 1,427,206 | 25.8 |
| 5 | 20 | 14.3 | 1,696,651 | 35.6 | 156,733 | 32.9 | 137,482 | 46.4 | 1,990,866 | 35.9 |
| Total | 140 | 100.0 | 4,764,585 | 100.0 | 475,770 | 100.0 | 296,299 | 100.0 | 5,536,664 | 100.0 |

[1]Size groups are defined in marketing animal units as size 1, under 15,000; size 2, 15,000-24,999; size 3, 25,000-39,999; size 4, 40,000-59,999; size 5, 60,000 and more.

hog markets with more than 46 percent of the total firms, while markets handling sheep account for less than 20 percent of the total.

The relationship between the distribution of firms and the proportionate volume of each specie handled is also of interest. The lack of precision in classification is pointed up by the fact that specialized firms do handle a small volume of other types of livestock. For example, Type 1 firms as a group handled almost 100,000 hogs—an average of over 200 per year for each market. On the other hand, the accuracy of this system is substantiated by the overall distribution. More than 96 percent of the hogs were marketed by firms in Types 2 and 4, while more than 97 percent of the sheep were handled by firms in Types 3 and 4.

### Auction Facilities

All auctions have a sales barn, pens, alleys, unloading and loading facilities. Beyond these basic facilities, the actual cost of physical plant may vary tremendously from one market to another. Some of this variation may be a result of climate in different parts of the state. Some is caused by the age of the markets, some is related to customs or practices within an area and some is due to the personal preferences or opinions of the auction owner as to the type of market that will permit him to operate most effectively within his competitive framework.

From a climatic standpoint, the greatest variation in physical plant is noticed between the high rainfall areas of eastern and central Texas and the more arid regions further west. The high rainfall necessitates roofs. Markets in Area 2 and Area 3 generally find it necessary to have their usual consignor pens and buyer pens protected by a roof, although they probably will not cover the less frequently used holding or overflow pens. Auctions in the other three areas often confine their roofed areas to the sales barn itself with minimum additional shedding to cover the hog pens. The difference in both original cost and maintenance of these two systems is sizeable.

Market age affects investment in physical plant from two standpoints. First, the physical plant of an older market will have depreciated considerably in both actual and book value. Second, the newer auctions generally have a much higher initial investment, since the trend in auction construction is toward more elaborate sales barns with modern facilities. The difference in the value of physical plants for markets of comparable size may be greater than would be anticipated from depreciation alone.

Marketing customs that affect the physical plant cost of auctions have developed in some areas. Chief among these is the provision of feed and water facilities in each pen. This practice is followed more consistently by markets in the western areas of the state than by those farther east. A combination of higher summer temperatures, greater distance from the ranch to the market and possibly greater producer awareness of the need for adequate water in the more arid regions has contributed to the development of this practice. The provision of these facilities in each pen materially affects plant costs.

An elaborate sales barn is built sometimes as a competitive device or, more particularly, as a means of competing for producer attendance. In these instances the operator attempts to provide the most comfortable facilities possible to attract rural families to the sale. By making his market a social gathering place as well as a business, he hopes to stimulate sales from local producers. Complete air-conditioning, restaurant facilities and theater-type seats are a few of the extra conveniences in these markets. Needless to say, the cost of constructing facilities of this type is considerably above average.

### Seasonality of Marketing

The regularity of movement through auctions is important to auction operations. One principal factor affecting variation in volumes is the seasonal marketing patterns. Seasonality adversely affects the efficiency of labor and other resources used in auction operations, especially during periods of low marketings. Auctions tend to construct physical plants sufficient to handle maximum anticipated volumes during peak marketing periods. Consequently, considerable excess capacity must be maintained throughout the year. This causes average costs to be higher than they would be otherwise.

TABLE 10. DISTRIBUTION OF AUCTIONS AND VOLUME OF MARKETINGS, IN MARKETING ANIMAL UNITS, BY MARKET TYPE

| Type[1] | Firms | | Cattle | | Hogs | | Sheep | | Total marketing animal units | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 1 | 48 | 34.3 | 1,751,319 | 36.7 | 9,821 | 2.1 | 2,286 | .8 | 1,763,426 | 31.8 |
| 2 | 65 | 46.4 | 2,344,075 | 49.2 | 399,742 | 84.0 | 5,522 | 1.8 | 2,749,339 | 49.7 |
| 3 | 13 | 9.3 | 179,301 | 3.8 | 7,930 | 1.7 | 122,874 | 41.5 | 310,005 | 5.6 |
| 4 | 14 | 10.0 | 489,990 | 10.3 | 58,277 | 12.2 | 165,617 | 55.9 | 713,884 | 12.9 |
| Total | 140 | 100.0 | 4,764,585 | 100.0 | 475,770 | 100.0 | 296,299 | 100.0 | 5,536,654 | 100.0 |

[1]Type 1 = Cattle auctions handling fewer than 1,000 hogs and fewer than 2,500 sheep.
Type 2 = Cattle-hog auctions handling more than 1,000 hogs and fewer than 2,500 sheep.
Type 3 = Cattle-sheep auctions handling fewer than 1,000 hogs and more than 2,500 sheep.
Type 4 = Multi-specie auctions handling, in addition to cattle, more than 1,000 hogs and more than 2,500 sheep.

Seasonality of livestock marketings at Texas auctions for 1962-64 is shown in Table 11. Since monthly volumes were not available from the records of individual firms, these data represent total sales through all Texas auctions during this period as reported by the Texas Crop and Livestock Reporting Service.

On the basis of total volume of all species, marketings were more than twice as high during the peak month, October, as they were in the lowest month, February. In general, periods of lowest marketings each year came during late winter and early spring. Heaviest movements came in late summer and early fall. There was some variation from year to year, but this was overshadowed by the fairly constant and much more violent seasonal swings.

In examining the seasonal movements of the individual species, the similarity of cattle marketings to total volume is apparent. Since cattle make up about 86 percent of total marketings, they exert the strongest influence on total sales. Hog movements have a minor winter peak then decline slightly and remain fairly constant throughout the remainder of the year. Specialized cattle auctions, then, would be expected to have seasonal patterns similar to those shown for all cattle marketings. The cattle-hog auctions would be expected to have less seasonality. The peak hog movement comes during the period of low cattle sales. The rather constant movement during the remainder of the year serves as a stabilizing influence on the fluctuation of total volume.

It is in the sheep markets that fluctuations are most severe. From a low of around 3 percent in February, volume increases to as much as 17 percent in May with the movement of the winter lamb crop. This means volumes may increase more than 500 percent during a 3-month period. The secondary peak comes during the August-October period and coincides with the peak cattle movements. Markets heavily oriented to sheep have a 5-month period (November-March) of abnormally low volumes. The addition of cattle does not materially help their position, since four of these same months (December-March) have lower than average cattle marketings.

With experience, auction operators are able to anticipate seasonal fluctuations and make some adjustments for them. It should be pointed out that these statewide averages do not apply uniformly to all sections of the state. Local range conditions, feed supplies and the availability of small-grain fields for grazing may be of overriding importance to the volume of individual auctions. In addition, the week-to-week variations sometimes may be fully as severe as seasonal differences. These fluctuations are difficult to predict. Therefore, it is hard to make adjustments for them.

## COST-VOLUME RELATIONSHIPS

Cost data in this study are taken from the annual reports of livestock auction markets. These reports provide a distribution of costs into 35 categories such as rent, depreciation, labor by major type and advertising. One of the major objectives is to determine the relationship between unit costs and auction volume using the information in these reports.

One of the first problems encountered was that of classifying the various expense items as either fixed or variable. Most items are neither entirely variable nor entirely fixed in actual practice. Hired labor, for example, is considered a variable cost although a minimum amount of labor is necessary for the market to function at all. Repairs and maintenance expenses are considered fixed costs; however, they will vary with usage or volume of livestock handled. The final classification, while based upon informed judgment, was made arbitrarily.

A second problem was the marked differences in reporting some cost items, particularly labor costs, among the smaller auctions. Many markets in the two smaller size groups reported extremely low hired labor costs. In a number of these smaller auctions the owner or operator performed one or more of the specialized jobs and did not charge a salary. Typically

TABLE 11. MONTHLY VARIATION IN MARKETING THROUGH TEXAS AUCTIONS, BY SPECIE, 1962-64[1]

| Month | Cattle | | | Hogs | | | Sheep | | | All species | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1962 | 1963 | 1964 | 1962 | 1963 | 1964 | 1962 | 1963 | 1964 | 1962 | 1963 | 1964 |
| | Percent | | | | | | | | | | | |
| January | 7.0 | 7.2 | 7.3 | 8.9 | 9.6 | 10.1 | 5.1 | 4.9 | 4.4 | 7.0 | 7.3 | 7.3 |
| February | 5.1 | 5.2 | 5.5 | 8.5 | 7.6 | 8.8 | 3.3 | 3.2 | 3.1 | 5.2 | 5.3 | 5.6 |
| March | 7.4 | 6.1 | 6.9 | 9.7 | 8.8 | 9.2 | 3.7 | 4.7 | 5.1 | 7.4 | 6.3 | 7.0 |
| April | 5.7 | 7.3 | 7.1 | 8.7 | 8.8 | 9.4 | 6.3 | 10.6 | 12.2 | 6.0 | 7.6 | 7.5 |
| May | 7.8 | 7.7 | 7.2 | 9.3 | 8.4 | 8.8 | 13.0 | 14.2 | 17.1 | 8.3 | 8.1 | 7.7 |
| June | 6.2 | 8.2 | 7.6 | 7.4 | 8.0 | 7.9 | 9.8 | 10.4 | 10.5 | 6.5 | 8.3 | 7.8 |
| July | 8.4 | 9.8 | 9.8 | 7.5 | 8.2 | 8.1 | 9.8 | 9.7 | 10.5 | 8.4 | 9.6 | 9.7 |
| August | 11.4 | 10.4 | 8.6 | 7.7 | 8.4 | 7.9 | 14.6 | 10.6 | 8.4 | 11.3 | 10.3 | 8.6 |
| September | 9.7 | 10.8 | 9.8 | 7.5 | 8.0 | 7.5 | 13.6 | 11.7 | 9.5 | 9.8 | 10.6 | 9.7 |
| October | 12.8 | 11.7 | 11.7 | 8.2 | 8.4 | 7.7 | 10.3 | 11.1 | 10.7 | 12.3 | 11.5 | 11.4 |
| November | 10.9 | 9.5 | 10.4 | 7.5 | 8.0 | 7.0 | 6.3 | 5.5 | 4.8 | 10.3 | 9.1 | 9.9 |
| December | 7.6 | 6.1 | 8.2 | 9.1 | 7.8 | 7.6 | 4.2 | 3.4 | 3.7 | 7.5 | 6.0 | 7.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Source: Compiled from reports of Texas Crop and Livestock Reporting Service.
[1]Includes volume data from all auctions in the state.

owners acted as ringman, starter and, on occasion, auctioneer. In addition, other family labor was sometimes employed on a no-salary basis. This usually involved the owners' wives serving as supervisors of the office force or handling financial transactions with buyers and consignors.

To achieve uniformity in accounting for these non-reported labor costs it would have been necessary to impute an average cost to each job and synthesize job costs at each market. This approach would yield much more realistic estimates of the unit costs facing firms that must hire all labor. It also would provide cost curves more consistent with the concept of alternative or opportunity costs.

This approach was not followed in this analysis for two reasons: One purpose of this study is to describe the cost-volume relationships as they actually are, using the markets' reported cost data. Second, in smaller markets, it is possible that managerial duties do not require the owner's full time. Managerial salaries, which were imputed to each market, may include some payment for secondary duties performed by the auction owner.

Subsequent analysis of cost functions should be interpreted with this major restriction in mind. With the exception of managerial salaries, all costs are the reported cash costs of the market. Economic costs, as distinguished from accounting costs, would be considerably higher among the low volume firms.

A third problem arose in handling those practices that did not apply to all markets. The most important was the practice of market support. It was decided to handle this particular practice outside the general cost-volume framework. For auctions which engage in market support, average unit costs should be increased by the appropriate costs associated with this practice.

### Market Support

There is a sharp difference of opinion among Texas auction owners as to the role the auction should play in supporting the market. Many auctions take the position that they are purely service establishments. Their function is to provide the facilities and services necessary to conduct the sale and bring the buyers and sellers together. They feel they have no responsibility in establishing or maintaining price levels.

In these markets the auction provides an opening bid, and the auctioneer starts selling at that bid. If a higher bid is not obtained from a buyer, the starter lowers his initial bid. This is continued until a bid has been received. Following this practice, the auction provides no price support; neither does it "catch" any animals that later must be resold. Consequently, there is no market support loss to add to other operating costs.

The majority of Texas auctions, however, feel that they have a responsibility to their consignors not to let their animals be sold much below market price. These markets may employ a professional livestock man as a starter, or the auction owner may do the job himself. In either case, the starter makes a firm opening bid on each lot of livestock as it enters the ring. If a higher bid is not received from another buyer, the auction takes title to the animals at the opening bid price.

Most markets with a market support policy will back up the opening bid only when a defect such as a bad eye or lameness is noticed subsequent to the starting bid. Since the starter only has a few seconds to appraise the livestock as it enters the ring, defects of this type are considered just cause for restarting the bidding at a lower level. The starter normally will try to start livestock slightly below his estimate of its final selling price. This gives buyers some bidding room and provides for a minimum margin of error in his original estimate of value. If started too low, the drawn out bidding unduly delays the sale. If too high, bidding competition is limited, and more animals are caught. The starter's skill is critical to efficient operation of the market.

Some markets may attempt to shift part of their market support risks by contracting with a starter to pay either a fixed starting fee or so much per head with the stipulation that the starter takes all animals caught. While this arrangement has the advantage of stabilizing market support costs, it relinquishes control over starting policies to someone outside the firm. Most auctions prefer to accept the risks involved in disposing of caught livestock and retain control over market support policies.

The extent of market support practices is shown in Table 12. Of the 140 firms studied, 125 were engaged in market support activities. In general, market support is more prevalent among the larger firms than the smaller. One reason may be that small firms realize they are not in a financial position to accept market support risks. The large firms use market support as a competitive device to attract or maintain seller volume.

A wide belief among auction operators is that the key to minimizing losses from market support accounts is a ready outlet for caught livestock. Many auctions have outlets with nearby packing houses to dispose of certain classes of livestock. Others operate feedlots or ranches and divert part of their market support livestock to these operations. They also may have nearby or contiguous grazing areas to hold livestock until the next sale. Still others sell to local traders or order buyers on a regular basis. In each case the auction operator is attempting to develop a minimum cost outlet for acquired livestock.

It is also widely believed that the larger markets are in a better position to minimize per unit costs

TABLE 12. SUPPORT ACCOUNT ACTIVITIES BY MARKET SIZE

| Characteristic | Unit | Firm size 1 | 2 | 3 | 4 | 5 | Total or average |
|---|---|---|---|---|---|---|---|
| Study markets | Number | 25 | 27 | 39 | 29 | 20 | 140 |
| Number with support account | Number | 16 | 26 | 36 | 28 | 19 | 125 |
| Total animal units marketed[1] | Number | 184,598 | 505,793 | 1,204,082 | 1,386,427 | 1,664,008 | 4,924,908 |
| Cattle caught | Number | 9,866 | 32,122 | 60,202 | 55,486 | 44,635 | 202,311 |
| Net loss on cattle | Dollars | 19,841 | 3,470 | 165,244 | 189,743 | 140,867 | 519,165 |
| Average loss per animal unit | Dollars | 2.01 | 0.11 | 2.74 | 3.42 | 3.15 | 2.57 |
| Hogs caught | Number | 716 | 2,086 | 17,887 | 2,294 | 13,094 | 36,077 |
| Net loss on hogs | Dollars | 908 | 2,931 | 7,008 | 7.037 | 13,178 | 31,062 |
| Average loss per animal unit | Dollars | 1.27 | 1.41 | 0.39 | 3.07 | 1.01 | 0.86 |
| Sheep caught[2] | Number | 476 | 1,506 | 4,065 | 391 | 3,143 | 9,581 |
| Net loss on sheep | Dollars | 848 | 5,877 | 6,585 | 1,198 | 10,422 | 24,930 |
| Average loss per animal unit | Dollars | 1.78 | 3.90 | 1.62 | 3.06 | 3.31 | 2.60 |
| Total animal units caught | Number | 11,058 | 35,714 | 32,154 | 58,171 | 60,872 | 247,969 |
| Total net loss | Dollars | 21,597 | 12,278 | 165,667 | 197,978 | 164,467 | 561,987 |
| Average loss per animal unit caught | Dollars | 1.95 | 0.34 | 2.02 | 3.40 | 2.70 | 2.27 |
| Percent of total marketings | Percent | 6.0 | 7.1 | 6.8 | 4.2 | 3.7 | 5.0 |
| Average cost per animal unit marketed | Dollars | .117 | .024 | .138 | .143 | .100 | .114 |

[1]Includes volume of firms with support activity only.
[2]Converted to animal units.

of support accounts than are small auctions. Because of the volume of livestock handled, the larger sales should obtain economies from lower unit cost of transportation to alternative markets, from better classification of livestock into more salable uniform bunches and from volume induced selling power. Because their catch comes from a much greater volume of livestock, their starters should be better able to evaluate market price; consequently, the difference between acquired price and true market price should be less than for the small firms.

If all these assumptions were true, the larger auctions should show a smaller loss per animal unit caught than the smaller ones. Actually, the reverse is true. Average loss per animal unit caught ranges from a high of $3.40 and $2.70 for Size 4 and Size 5 to $1.95 and $0.34 for Sizes 1 and 2, respectively. The same general relationship appears to hold true regardless of specie of livestock.

Two possible explanations are advanced for this seemingly inverse relationship. First, the small sales handle a much lower volume of livestock during a single sales day. Consequently, they are not under pressure to maintain a high rate of sales in order to complete all transactions within a reasonable time period. The more leisurely pace allows the starter more time for a first evaluation of the animal and also allows him to start the bidding somewhat lower than required in a more rapid pace market.

If this explanation is accepted, it would seem that the same conditions would result in a lower proportion of caught livestock in relation to total volume handled. However, the small markets catch a higher percentage of their total volume than do the larger markets, Table 12. This probably results from the small number of livestock in each class in small markets and the limited buying power of available buyers. A market handling 300 animal units per day may have over 20 classes of livestock at one sale ranging from light stocker steer calves to fat cows. Its buyers may consist almost entirely of local farmers, small feeders, locker plant operators and local traders—each with specific needs, but limited buying power. The auction must determine the local demand for livestock in each class, and in process of doing so it may catch some from each group. The absence of buyers or the satiation of buyers for a particular class may force the market to catch a larger portion of that class to prevent disastrous price breaks.

The larger auctions, on the other hand, may have little more variety in classes of livestock but a much greater volume in each. It also will have a more diverse group of buyers and considerably more buyer strength. Consequently, these markets can catch a larger number of livestock from each class and still have that catch represent a lower percentage of total volume!

Lower costs per animal unit caught by the small markets may lie in their method of disposing of caught livestock. The practice of rerunning caught livestock is more common among the smaller firms. Many small auctions, recognizing the problems involved in marketing small lots of non-uniform livestock, prefer to take their immediate loss by running company cattle back through the ring as soon as possible. In this way their loss is restricted to the overestimate in price alone. No additional feed, transportation and selling expenses are incurred. This may be a more efficient method of handling these livestock when all costs are considered.

The primary objective of this section, however, is to point up the effect that market support activities have on the average costs of those markets engaging in this practice. For markets of all sizes, the average marketing cost is increased about 11.4 cents per head. This ranges from a low of only 2.4 cents for Size 2

markets to a high of 14.3 cents for firms in Size 4. Auctions that provide market support should evaluate the benefits derived from this practice in light of its effect on average cost.

Since market support costs are not incurred by all markets, these costs are not included in the general analysis of variable and fixed costs, nor are they included in the derived cost curves. This omission should be kept in mind when interpreting these cost data.

## Variable Costs

True variable costs are those costs that are a function of output. They are expected to vary directly with output for a plant of a given scale, although not necessarily in proportion to changes in volume. When the plant is idle, variable costs are expected to be zero.

For the most part, those items included as variable costs here will meet this definition. Other cost items, such as automobile and travel expenses and bad debts which would revert to zero if the firm were to cease operation altogether, have not been included as variable costs. Within the analytical framework used, the pertinent question is not which costs would stop altogether with a cessation of operations, but which costs are logically a function of changes in volume for plants in operation.

The condition of plant operation is accepted as a basic assumption. Consequently, individual cost items were examined from the viewpoint of whether they could be expected to vary directly with volume or whether they would be related more nearly to plant size, investment and managerial practices. Those judged to be most related to volume were categorized as variable costs.

### *Hired Labor*

Hired labor is the firm's largest single expense item. This is considered a variable cost although minimum labor is required to operate the market at any output level. These operational requirements tend to add some fixity to labor costs.

Since hired labor costs constitute a major percentage of total variable costs, they will be discussed by major labor categories. It should be repeated that these figures reflect only the reported cash outlays for hired labor. In many smaller auctions one or more of these jobs may be performed by the auction owner and no labor charge made. Table 13 shows the major elements of auction labor on a unit cost basis.

AUCTIONEER. The auctioneer is a key individual in a livestock auction. It is his responsibility to establish the proper tempo of the sale. To do this he must encourage competitive bidding by the buyers but know when further selling efforts are unproductive. He must know the buyers and their buying practices and must convince the consignor that he has obtained the highest possible price for his livestock.

TABLE 13. MAJOR CATEGORIES OF HIRED LABOR COST PER ANIMAL UNIT HANDLED BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Auctioneer | .119 | .113 | .096 | .086 | .076 | .089 |
| Weighmasters and ringmen | .151 | .084 | .052 | .050 | .039 | .055 |
| Office employees | .218 | .213 | .197 | .172 | .158 | .179 |
| Yard labor | .426 | .450 | .442 | .437 | .475 | .453 |
| Extra help and other | .058 | .125 | .076 | .096 | .056 | .078 |
| Total hired labor | .972 | .985 | .863 | .841 | .804 | .854 |

He also must know the most efficient selling rate for his particular market and gear his sales pace to that rate.

Auctioneers normally are employed on a contract basis by auctions, and experienced auctioneers may work two or more nearby sales per week. The fee usually is established as so much per sale, although some contract on a basis of a fixed amount per head. Others use combinations of these practices with a minimum fee supplemented by head payments if the run exceeds a given level. Small auctions only use one auctioneer per sale, while markets with large runs and long selling hours normally will use two.

The unit cost of auctioneering services ranges from a high of almost 12 cents per head for the smallest group of auctions to 7.6 cents for the largest. A few of the smaller market owners reduce this expense by serving as auctioneers for their sales, but this is not a common practice. The advantages of having a professional auctioneer usually are recognized even in the smaller markets.

A competent auctioneer is especially critical to markets with large daily runs where efficiency is geared directly to selling speed. Selling rates that are too fast may cause costly errors in accounting for or penning animals; rates too slow may drag out the sale into costly overtime for all hired labor. Consequently, large volume markets are willing to pay a much higher rate per sale for top auctioneers. This keeps the unit cost somewhat higher than might be anticipated from auctioneering time alone.

WEIGHMASTER-RINGMAN. Since a large percentage of livestock are sold on a weight basis, each auction must have a set of scales and employ a bonded weighmaster to operate them. It is his duty to weigh the animals, stamp the weight on the scale ticket and, in many cases, assign the animals to the proper buyer pens. Auctions normally employ only one weighmaster regardless of their sales volume.

The ringman is responsible for animals in the sales ring. It is his duty to exhibit the animals, perform any sorting operations necessary in the ring and move them on to the scales as soon as they have been properly displayed. He normally will be assisted by one or more members of the yard crew who handle

inlet and scale gates. However, these men are charged to the yard crew. The ringman also may be the starter and in many auctions may assist the auctioneer by soliciting and relaying bids from buyers. In auctions where the owner performs a job apart from managerial duties, he often may serve as ringman.

The economies of size are apparent for these functions. Unit costs range from more than 15 cents per head for the smallest markets to only 3.9 cents for the largest ones. Since only one man is used in each of these functions regardless of market size, variations of this magnitude could be expected. Greater variations might have been revealed if owner salaries had been charged to these functions in all the smaller markets.

Office Employees. The number of employees in the office force will vary with market size and auction policy. Some auctions try to have an office force of sufficient size to be able to pay a consignor immediately after his animals are sold or to present a bill to buyers as soon as they have completed their purchases. They feel that the extra cost is justified by customer good will. Other markets prefer to sacrifice speed of handling for more efficient office operations.

Included in the office force normally will be the office manager, bookkeeper, ticket writer and paymaster or check-writer. In the smaller markets the office manager may serve also as the bookkeeper or paymaster, and both jobs may be performed by the auction owner or his wife. In larger markets additional clerical workers may check tag numbers, make extensions of sales slips and share the accounting load. Extra employees are needed particularly in markets with rapid selling rates to complete all transactions shortly after selling is concluded.

Unit cost for office employees averages almost 18 cents per animal unit for all markets combined. Proportionate variations in unit costs are not great between auctions of different sizes, but there are definite economies of size. From 21.8 cents per unit for the smallest firms, costs decrease to 15.8 cents for the largest auctions. Again, the variation would have been greater if owner and family labor were reported as cash costs in all the smaller markets.

Yard Labor. The largest category of labor costs is yard labor. This includes moving livestock from consignor's trucks through penning, selling, repenning and loading out in buyer trucks. It also includes the cost of one or more full-time employees hired to receive and load out livestock during the remainder of the week and to feed, water and care for livestock at the auction other than on sales days.

There do not appear to be economies of size in yard labor. Unit costs of 47.5 cents per animal unit are higher in the largest auctions than in any other size group. As the size of the auction pen layout increases, the average distance livestock must be driven in each yarding operation also increases. Efficiencies from specialization in labor are thereby offset by inefficiencies arising from greater distances. Another major factor affecting efficiency in the larger markets is the increased number of buyers and sellers associated with greater volumes and higher selling speeds. As these increase, the problems of animal identification, proper pen assignment and proper loading-out grow more acute. As a result, large auctions must hire additional labor to keep their sales running smoothly.

Extra Help and Other Labor Expenses. Extra help includes occasional labor costs for auction clean-up and irregular jobs that cannot be handled by the yard crew on sales days or by regular employees. Also included in this category are those labor-associated costs such as Social Security.

Lowest unit costs were attained by auctions in the extreme size groups. Both had costs of less than 6 cents per head compared to 12.5 cents for auctions in size group 2 and 9.6 cents for those in Size 4. In the small markets most of these extra jobs are handled by the owner during non-sale days. The large auctions have full-time employees. They handle most irregular jobs, and the cost is included with yard labor.

Total Hired Labor. The variation in total hired labor ranges from 98.5 cents per animal unit for markets in size group 2 to 80.4 cents for the largest firms. Practically all the labor economies are accounted for by more efficient use of weighmasters, office employees and auctioneers by the larger firms. These efficiencies are offset to some degree by less efficient use of yard labor.

### *Advertising*

Texas livestock auctions use a variety of means to publicize their markets. These range from impersonal or institutional advertising to personal contact with buyers and consignors. A number of auctions issue weekly market letters giving a rundown of volume and prices at the last sale and describing the consignments and buyer representation anticipated at the next sale. The practice of reporting portions of the sale over local radio stations is common, especially among the larger markets. Newspaper advertising is used extensively as is advertising in programs of local civic and youth organizations.

The effect of direct advertising outlays on unit costs is shown in Table 14. Average cost per animal

**TABLE 14. ADVERTISING COSTS PER ANIMAL UNIT BY FIRM SIZE**

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Direct advertising | .047 | .044 | .052 | .063 | .064 | .058 |
| Telephone | .044 | .043 | .038 | .035 | .023 | .033 |
| Total | .091 | .087 | .090 | .098 | .087 | .091 |

TABLE 15. SUPPLY COSTS PER ANIMAL UNIT BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | — — — — — Dollars — — — — — | | | | | |
| Office supplies | .058 | .054 | .036 | .036 | .034 | .038 |
| Yard supplies | .043 | .031 | .032 | .029 | .021 | .028 |
| Total | .102 | .085 | .068 | .064 | .055 | .066 |

unit for direct advertising tends to increase with firm size, while the personal contact, represented by telephone costs, shows the reverse relationship. This indicates that the small auctions, having a more compact trade territory, place more emphasis on direct customer contact through telephone calls. The large markets rely more heavily on commercial advertising to reach their customers.

Advertising costs show no pattern of variation with size of auctions. Regardless of firm size, total advertising costs average about 9 cents per animal unit marketed.

*Supplies*

All livestock auctions require sizable quantities of supplies, the amount being determined largely by the volume of livestock handled. For example, a calf consigned to an auction market is tagged with an identifying number upon arrival. A consignor sheet, sale sheet, scale ticket and buyer sheet will be prepared as it moves through the selling process. A check will be issued in payment to the consignor, and a statement prepared for the buyer. This requires many office supplies.

In addition to tags and glue, yard supplies include whips and canvas slappers, sand or sawdust for the ring, sprays and insecticides and miscellaneous items.

Total supply costs per animal unit decreased consistently with firm size. Larger average consignments in the bigger markets required fewer tags, forms and records per animal unit. There are also economies associated with volume purchasing in the larger firms. As shown in Table 15, average supply costs varied from a high of 10.2 cents per animal unit in Size 1 firms to 5.5 cents in Size 5 firms.

*Bonds, Bank Charges and Income Taxes*

These costs vary directly with the volume of business although not in direct proportion to volume. Bonding requirements are established by the Packer and Stockyards Act and are based directly upon the dollar value of business conducted. In general, the amount of the bond is established as the average dollar volume of one sales day with a minimum of $5,000 and a maximum of $50,000 plus 10 percent of the volume in excess of $50,000. For example, a market selling 50 days per year with annual volume of $1 million would require a bond of $20,000. If that market increased its volume to $10 million, with the same number of sales days, its bond would be increased to only $65,000.

TABLE 16. BOND, INCOME TAX AND BANK CHARGES PER ANIMAL UNIT BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | — — — — — Dollars — — — — — | | | | | |
| Bonds | .009 | .005 | .007 | .005 | .003 | .005 |
| Bank charges | .016 | .003 | .009 | .005 | .003 | .006 |
| Income tax | .005 | .004 | .009 | .021 | .025 | .017 |
| Total | .030 | .012 | .026 | .031 | .031 | .028 |

Bank charges, as distinguished from interest, are those charges made for handling the large number of transactions necessary in auction operations. Income taxes are paid by auctions that operate as partnerships.

Unit bonding costs and bank charges decrease with increases in firm size. Partnership income taxes, however, are higher for the larger firms because of the progressive rate structure and the greater proportion of individual ownership among the small firms. As a consequence of these divergent relationships, average total costs for this group show no consistent variations with changes in firm size.

*Utilities*

Total utility costs vary considerably among auctions even within the same size groups. Some markets have well lighted yard facilities, while others have minimum pen lighting except in loading areas. Some markets have complete water facilites, while others have water in only a few pens. Air conditioning the sales barn, while becoming more prevalent among all auctions, still is not practiced uniformly. Keeping the auction building open on non-sale days also affects utility costs.

Variations in unit costs for markets of different sizes are shown in Table 17. Large auctions tend to spend a greater absolute amount for utilities, but the larger volumes decrease the average cost per marketing unit. As a result, average unit costs are highest in the small markets and lowest in the large ones.

TABLE 17. VARIABLE COSTS PER ANIMAL UNIT BY MAJOR CATEGORY BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | — — — — — Dollars — — — — — | | | | | |
| Hired labor | .972 | .985 | .863 | .841 | .804 | .854 |
| Advertising | .091 | .087 | .090 | .098 | .087 | .091 |
| Supplies | .102 | .085 | .068 | .064 | .055 | .066 |
| Utilities | .043 | .037 | .039 | .037 | .029 | .035 |
| Bonds, bank charges and income tax | .030 | .012 | .026 | .031 | .031 | .028 |
| Transportation | .068 | .067 | .016 | .026 | .012 | .069 |
| Miscellaneous | .073 | .093 | .056 | .039 | .040 | .050 |
| Total | 1.378 | 1.366 | 1.158 | 1.136 | 1.058 | 1.193 |

### *Transportation*

Transportation charges consist largely of those costs associated with the auctions owning and operating their own trucks. Most auctions own one or more trucks ranging from pick-up trucks to large combination tractor-trailers. These vehicles are used to haul equipment, supplies and miscellaneous items to and from the market. They are also useful in hauling off manure, while large trucks haul feed and livestock. Some auctions have transportation available for the use of consignors and buyers. While commercial rates are supposed to be charged for these services, payments often fail to cover full ownership costs.

Transportation expense tends to increase with market size but not in proportion to volume handled. Unit costs range from 6.8 cents per animal unit handled in Size 1 markets to 1.2 cents for markets in Size 5.

### *Miscellaneous*

Included as miscellaneous variable expenses are items that may not be common to all markets and some that are relatively insignificant. However, they add significantly to operating costs. Among them are such minor costs as postage, freight and losses due to weighing errors. More significant are losses from the death or crippling of livestock in the market, payments for lost livestock and the costs of disposing of dead animals. Brand inspection is also a sizable cost item. As a courtesy to customers, some auctions handle livestock medicines and vaccines at a net cost to the market.

The unit cost of miscellaneous items tends to decrease with size of market, although the relationship is not precise. Highest unit costs were found for markets in Size 2, while lowest costs were recorded by markets in Size 4, Table 17. In general, costs in the two smaller size groups were considerably lower than in the two larger groups.

### *All Variable Costs*

When all variable costs are combined, Table 17, the differences in unit costs for firms of different sizes are readily apparent. Cost per animal unit handled declined from $1.38 for firms handling less than 15,000 animal units annually to $1.06 for firms with annual volumes in excess of 60,000. A more precise relationship is shown later by graphic illustration with the development of average cost curves.

## Fixed Costs

True fixed costs are defined as those costs which, for a given size firm, remain constant in total amount regardless of the volume handled by that firm. If the firm were to cease operations altogether, these costs would continue to be incurred.

For this analysis, this definition has been broadened to include some cost items that would not qualify as fixed costs under the more restrictive definition. Bad debts and travel expenses, for example, would be expected to revert to zero with the cessation of plant operations, thereby failing to qualify as true fixed costs. However, a basic assumption is that the plants under examination are in operation.

It is considered more useful to this study to categorize costs in a slightly different manner, recognizing there will be elements of fixity in most variable costs and some variability in many items of fixed cost. Those cost items which are judged most nearly a function of plant size, investment and managerial practices are classed as fixed costs.

### *Management Salary*

Livestock auctions are operated under four basic ownership patterns. These range from the simple individual ownership through formal partnerships, corporate ownership and cooperative or association ownership. The first three are common among Texas auctions, while none of the study firms were operating as cooperatives.

Regardless of the type of ownership, management decisions must be made by someone with authority to implement those decisions. In single ownership auctions the auction owner usually serves as manager and, in the smaller markets, may perform additional duties as well. In partnership arrangements one or both partners may provide managerial skills and, again in the smaller markets, also may perform additional jobs. In the formal corporations, a principal officer (usually the president or vice president) normally serves as general manager. Since this type of ownership is more common in the larger markets, the officer-manager is less likely to perform a specific job on sales day other than supervise operations.

Allocating a specific salary to management is not common to all markets, Table 18. It was practiced most consistently by the largest markets and became progressively less common as market size decreased. Of the 140 markets studied, only 63 paid a salary to

TABLE 18. MANAGEMENT SALARIES PAID IN RELATION TO FIRM SIZE, TEXAS STUDY AUCTIONS, 1962

| Characteristic | Unit | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|---|
| Markets reporting management salaries | Number | 8 | 9 | 18 | 14 | 14 | 63 |
| Markets not reporting management salaries | Number | 17 | 18 | 21 | 15 | 6 | 77 |
| All markets in study | Number | 25 | 27 | 39 | 29 | 20 | 140 |
| Average salary reported | Dollars | 4,268 | 6,616 | 9,017 | 16,187 | 23,100 | 11,203 |
| Average cost per animal unit | Dollars | .366 | .341 | .270 | .329 | .232 | .283 |

management. In the remaining 77, net returns were considered to include a combined return to management and an ownership profit.

In order to place all markets on a comparable base, it was necessary to impute a return to management to those markets not showing this cost. The assumption made was that management opportunity cost would be consistent within markets of comparable size or that the average salary paid by reporting markets accurately reflected management costs for all markets in that size group. Using this assumption, the average management salary for reporting markets of a particular size group was imputed to all non-reporting markets of that same size.

Although the average management salaries increased rapidly with firm size, they generally failed to increase as rapidly as volume. As a result, average cost per animal unit handled was highest in Size 1 markets and lowest in Size 5 firms. This relationship was consistent throughout the size ranges with the exception of Group 4 firms. For all markets, management salaries represented a cost of 28.3 cents per animal unit handled.

### *Rent and Depreciation*

Rent and depreciation are considered together, since they are measures of some of the same costs for auctions operating under different ownership arrangements. Many Texas auctions are not operated by the owner of the facilities but are rented or leased. In these cases the operator will not charge depreciation for facilities and equipment he does not own. Instead his rental or lease payments are assumed to cover both investment and depreciation costs. Rent may be either a fixed annual fee, a percentage of gross income or a combination minimum fee plus a percentage of the gross income above a certain level.

Depreciation is the non-cash cost resulting from use and obsolescence of buildings, pens and equipment. It should be recovered during the useful life of the facilities and equipment to provide a reserve for replacement. Methods of allocating depreciation vary with different accounting systems. Perhaps the most common system used by auctions is the straight-line method wherein original investment is recovered over a fixed number of years in equal annual increments. The number of years used as a depreciation base may vary from auction to auction and between specific items. A previous study of Texas auctions has suggested depreciation periods of 25 years for buildings, 15 years for pens, 30 years for scales and 10 years for other equipment.

Depreciation charges vary considerably among auctions even within the same size group. Auctions that have been in operation for a long time may have depreciated their facilities already. Older auctions generally were constructed at considerably lower cost per unit of capacity than the newer firms because of lower labor and material costs and more modest design criteria.

**TABLE 19. RENT AND DEPRECIATION COSTS PER ANIMAL UNIT BY FIRM SIZE**

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Rent | .082 | .046 | .028 | .094 | .070 | .065 |
| Depreciation | .098 | .117 | .106 | .095 | .069 | .090 |
| Total | .180 | .162 | .134 | .189 | .139 | .155 |

Average unit costs for both rent and depreciation are shown in Table 19. Neither follows a consistent pattern of variation with firm size. Since both items are largely measures of a common cost, it should be expected that high unit costs for depreciation would be offset by low unit costs for rent (as in firm Sizes 2 and 3). Total rental charges for the firms renting in a particular size group are divided by total volume for all firms in that group. If a few firms rent, unit costs will be low for rent charges and high for depreciation. The total for both items, then, is the more significant measure. With some deductions for other ownership payments in the case of rent, the total may be considered as the non-cash ownership costs of markets of different sizes. These costs, averaging 15.5 cents per animal unit for all firms, do not show a consistent relationship to volume of livestock handled.

### *Repairs and Maintenance*

Maintenance and repair expenses vary considerably between auctions, depending upon the size of the physical plant, climatic conditions, quantity and type of equipment used, kinds of livestock handled, the maintenance schedule followed and—perhaps most important—the age and condition of the auction. A well constructed new auction will spend less for maintenance and repair than an older auction.

The larger auctions with more facilities naturally will have more maintenance to perform. Exposed facilities of auctions located in high rainfall areas will deteriorate more rapidly, while those handling a high proportion of nervous livestock will have more extensive pen and gate repairs. Management practices, particularly the establishment of routine maintenance programs, are also important in determining total maintenance and repair costs.

**TABLE 20. REPAIR AND MAINTENANCE COSTS PER ANIMAL UNIT BY FIRM SIZE**

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Equipment | .016 | .003 | .004 | .008 | .005 | .006 |
| Building | .017 | .047 | .031 | .032 | .024 | .029 |
| Yard | .045 | .041 | .032 | .033 | .026 | .031 |
| Total | .077 | .091 | .066 | .072 | .056 | .067 |

Variations also are caused by the manner in which these costs are reported by different firms. Some markets have salaried employees who work at the market throughout the week. They may handle routine repair jobs as a part of their regular work schedule. In those cases actual maintenance cost may be partially hidden in labor costs. In very small markets the owner may perform most maintenance himself and make no charge to either cost account.

Repair and maintenance costs on a unit basis indicate a general tendency toward economies of size, although the relationship is not consistent between size groups. For example, building maintenance cost per animal unit handled is lowest for the smallest firms. This is probably a result of low capital investment in buildings plus the tendency for building repairs to be either indefinitely postponed or performed by the owner. Yard repairs, on the other hand, are highest for firms in this group, indicating that a minimum pen condition must be maintained in order to handle livestock at all.

### *Automobile and Travel*

These expenses were included as fixed costs because they were considered more nearly related to managerial philosophy than to volume of livestock handled. Practically every auction has at least one automobile, the expense of which is partially or entirely charged off to the operation of the market. A common practice is for the auction to own the automobile and to pay all operating expenses incurred in its use for business purposes. To this extent an automobile may be considered fixed auction equipment.

Travel costs also include sizable elements of fixity for most auctions. Generally included as major cost items in this category are all expenses incurred by auction owners, officers and managers in attending state and national auction association meetings plus other travel not specifically related to generating business volume. A portion of this expense is more variable in nature, however, and fluctuates with changes in volume of livestock handled.

Average automobile cost per animal unit appears to be directly related to auction volume. These costs range from a high of 5.3 cents per animal unit for the smallest firms to a low of 2.2 cents for the largest markets. Travel costs on the other hand, do not follow the same trend. Costs are highest for Size 3 firms, but actual variation is not great between the different auction size groups.

TABLE 21. AUTOMOBILE AND TRAVEL COSTS PER ANIMAL UNIT BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Automobile | .053 | .044 | .040 | .031 | .022 | .032 |
| Travel | .028 | .024 | .041 | .030 | .034 | .033 |
| Total | .080 | .068 | .080 | .061 | .056 | .065 |

### *Insurance*

Insurance costs vary considerably between auctions depending upon the amount of insurance carried and the appropriate insurance rate. The amount of insurance carried in turn depends upon the market owner's liability to bear the risk himself and his desire to shift part or all of this risk. The rate depends upon the location of the market (whether it is inside or outside city limits) and the construction of the auction building.

These variations in cost per auction are reflected in the average insurance cost per animal unit, Table 22. Lack of greater fluctuations in unit costs may be explained by the amount of insurance carried by different size firms. Larger markets generally have substantial investments in auction facilities. To protect these investments they tend to have full insurance coverage. The small markets are more likely to carry minimum insurance. When converted to a unit cost basis, insurance cost per animal unit reveals only small economies accruing to larger firms.

### *Taxes*

Texas auctions are all subject to certain property taxes. County, state and school taxes normally are collected from all markets. Tax costs in relation to actual value depend upon local assessment ratios and tax rates. Auctions located within city limits also will be subject to city taxes, and those in certain areas may be subject to personal property taxes. These latter two taxes are relatively rare among Texas markets.

The effect of taxation on auction operating costs is relatively insignificant. Total tax costs average only 1 cent per animal for all auctions combined. Variations range from 1.4 cents for markets in Size 2 to 0.7 cents for Size 5 firms.

### *Interest*

Interest costs, as reported by Texas auctions, are cash interest payments only. As such they do not

TABLE 22. FIXED COSTS PER ANIMAL UNIT BY MAJOR CATEGORY BY FIRM SIZE

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Rent and depreciation | .180 | .162 | .134 | .189 | .139 | .155 |
| Salaries of owners | .366 | .341 | .270 | .329 | .232 | .283 |
| Insurance | .063 | .065 | .059 | .057 | .052 | .057 |
| Taxes | .010 | .014 | .012 | .009 | .007 | .010 |
| Interest | .037 | .055 | .026 | .029 | .022 | .029 |
| Repairs and maintenance | .077 | .091 | .066 | .072 | .056 | .067 |
| Auto and travel | .080 | .068 | .080 | .061 | .056 | .065 |
| Bad debts | .035 | .044 | .045 | .057 | .042 | .046 |
| Miscellaneous | .050 | .081 | .094 | .039 | .033 | .054 |
| Total | .898 | .921 | .786 | .842 | .639 | .766 |

reflect true and complete interest charges. True interest should include the complete opportunity cost of investing capital in auction land, buildings and facilities, for once the investment is made, this capital cannot be diverted to other sources.

Auction owners that have a high equity in their facilities will show low cash interest costs, while those with a low equity will have higher cash costs. Cash interest charges, then, may have only a casual relationship to total investment. Since it was impossible to accurately estimate total investment from the records available, reported interest payments are used with the realization that they understate true interest costs by an unknown but sizable amount.

The contribution of interest charges to average operating costs is shown in Table 22. With the exception of firms in size group 2, the average cost per animal unit handled does not vary greatly with firm size. The higher costs in this one group may indicate either a higher investment per unit or a lower owner equity. Since depreciation charges were also unusually high for this group of firms, somewhat larger investment levels may be suspected.

*Bad Debts*

Practically all auction transactions are conducted by checks or bank drafts. Considering the number of checks received by a market, it is almost inevitable that some losses will be incurred from bad checks. These may range from deliberate fraud perpetrated by professionals to more "honest" losses arising from the bankruptcy of legitimate buyers.

Apparently one of the most frequent causes of "hot" checks is the practice of permitting buyers to operate on a "float." Some markets, in an effort to increase buyer strength, will permit traders or speculators to delay payment for their purchases until the livestock can be resold, usually a few days later. A sharp break in prices or a series of buying errors may then place the speculator in a position where he cannot cover his outstanding check to the auction. In this practice the auction owner is actually assuming a high risk for the additional buyer strength he receives. Of course, all markets, including the majority that insist on immediate payment, are subject to the financial integrity of their buyers.

The effect of bad debts on average operating costs is most severe among the larger markets. Highest costs per animal unit were recorded by firms handling between 40-60,000 animal units per year, Table 22. Those handling under 15,000 had the lowest costs. Owners of small community-oriented auctions can personally evaluate their limited number of buyers. As the number of buyers increases, personal evaluation is replaced by more standardized financial checks.

*Miscellaneous*

Miscellaneous fixed costs include a number of cost items that are reported individually by most auctions but constitute such small additions to average unit cost that they are not shown individually here. Of these items, organization dues, subscriptions to market reports, journals and magazines, charity and contributions and legal and accounting fees together add an average of only 2 cents to unit costs. Other items considered fixed costs by some auctions include veterinary fees, post office box rent, scale testing charges, mowing costs, contributions to the screwworm eradication program and the cost of laundering employee work clothes.

When all miscellaneous fixed costs are combined, they add an average of 5.4 cents per animal unit to the cost of all firms. This cost varies sharply between firm size groups with no tendency toward uniformity. Highest costs of 9.4 cents per animal unit were shown by firms in Size 3, while costs of only 3.3 cents were reported by the largest firms.

*All Fixed Costs*

Table 22 shows a summary of the nine major fixed cost categories by firm size. The general tendency is for total fixed costs per animal unit to decrease as volume of livestock handled increases. However, highest costs per animal unit are shown by firms in Size 2 rather than Size 1 as might be expected. The lower level of costs by the small firms may result from the greater average age and poorer physical condition of those markets as reflected by low charges for insurance, taxes and building maintenance expenses. The fact that most of these markets are submarginal operations also tends to keep cash cost outlays at a minimum. Economic costs would undoubtedly be considerably higher.

## Total Costs

Total costs represent the sum of variable and fixed cash costs. Variable costs account for approximately 60 percent of the total for all firms, and the proportionate distribution of costs does not change materially between the different size groups, Table 23.

Two relationships shown here deserve some explanation. These are the failure of average total costs to decrease between Size 1 to Size 2 firms and, again, between Size 3 and Size 4 firms. The small firms have low cash outlays because of the use of family labor and low net investment in facilities. These markets are sub-marginal as a group and are probably operating under conditions of short-run capital disinvestment.

**TABLE 23. VARIABLE, FIXED AND TOTAL COSTS PER ANIMAL UNIT BY FIRM SIZE**

| Item | Firm size 1 | 2 | 3 | 4 | 5 | Average |
|---|---|---|---|---|---|---|
| | Dollars | | | | | |
| Variable costs | 1.378 | 1.366 | 1.158 | 1.136 | 1.058 | 1.193 |
| Fixed costs | .898 | .921 | .786 | .842 | .639 | .766 |
| Total costs | 2.276 | 2.287 | 1.944 | 1.978 | 1.697 | 1.959 |

TABLE 24. COST ADVANTAGE OF SIZE 5 FIRMS OVER SIZE 1 FIRMS BY COST ITEM

| Cost item | Advantage per marketing unit |
|---|---|
| | dollars |
| Variable cost items | |
| Hired labor | .168 |
| Advertising | .004 |
| Supplies | .047 |
| Utilities | .014 |
| Bonds, bank charges and income tax | —.001 |
| Transportation | .056 |
| Miscellaneous | .033 |
| Total | .320 |
| Fixed cost items | |
| Rent and depreciation | .041 |
| Owners' salaries | .132 |
| Insurance | .011 |
| Taxes | .003 |
| Interest | .015 |
| Repairs and maintenance | .021 |
| Auto and travel | .024 |
| Bad debts | —.007 |
| Miscellaneous | .017 |
| Total | .259 |
| All costs | .579 |

The higher unit costs in Size 4 firms are due almost entirely to high rent—depreciation and owners' salaries. Rather than decreasing with volume handled, both categories of fixed costs were higher than for either Size 3 firms or for all firms combined. This would indicate that this group included a higher proportion of the newer markets with greater investments in plant and facilities. This explanation carries with it a further assumption that management salary may be directly related to, or a function of, total capital investment as well as volume of business.

Even with these two discrepancies, the trend of declining unit costs is unmistakable between the smallest and largest market groups. In almost every category the cost of selling an animal is lower in the larger firms. Table 24 shows the estimated cost advantage enjoyed by Size 5 firms over the smallest firms in Size 1. In the aggregate they amount to almost 60 cents per marketing animal unit handled.

TABLE 25. CORRELATION BETWEEN TOTAL VARIABLE COST AND VOLUME OF LIVESTOCK HANDLED BY FIRMS IN DIFFERENT SIZE GROUPS

| Firm size | Coefficient[1] | $R^2$ | Standard deviation | T-value | Probability of Type I error[2] | F value |
|---|---|---|---|---|---|---|
| 1 | 1.37 | .88 | .105 | 13.06 | .000001 | 170** |
| 2 | 1.36 | .94 | .065 | 21.09 | .000000 | 445** |
| 3 | 1.14 | .94 | .046 | 24.74 | .000000 | 612** |
| 4 | 1.12 | .96 | .042 | 26.44 | .000000 | 699** |
| 5 | .92 | .90 | .069 | 13.34 | .000001 | 178** |
| All markets | 1.00 | .91 | .026 | 37.54 | .000000 | 1,409** |

[1]The coefficient denotes the anticipated change in variable cost associated with a unit change in the volume of livestock handled.
[2]A Type I error is made when a true null hypothesis is rejected.
**Denotes statistical significance at the 1 percent level.

TABLE 26. DISTRIBUTION OF FIRMS INTO COMBINED SIZE GROUPS FOR REGRESSION ANALYSIS

| Class interval | Number of firms | Average number of animal units handled |
|---|---|---|
| 5,000- 9,999 | 6 | 7,341 |
| 10,000-14,999 | 19 | 13,030 |
| 15,000-19,999 | 17 | 17,388 |
| 20,000-24,999 | 10 | 22,863 |
| 25,000-29,999 | 8 | 27,524 |
| 30,000-34,999 | 15 | 32,052 |
| 35,000-39,999 | 16 | 37,609 |
| 40,000-49,999 | 15 | 43,195 |
| 50,000-59,999 | 14 | 55,663 |
| 60,000-79,999 | 10 | 69,716 |
| 80,000-99,999 | 6 | 87,120 |
| 100,000-Above | 4 | 192,746 |

## Cost Curves

The discussion to this point has shown only general relationships between unit cost and volume of auctions grouped into broad categories of average market size. Through use of regression models, quantitative relationships between cost and volume of livestock handled need to be developed to derive planning curves for Texas auctions.

The simple linear regression models used to determine a marketing animal unit indicated a high linear correlation between cost and number of livestock handled for the 92 markets handling all species. This linear relationship was further examined by postulating a total variable cost function that was linear in the volume variable and constrained to pass through the origin. The model,

$$Y = bX_1,$$

where Y denotes total variable cost and $X_1$ denotes volume in marketing animal units handled, was applied to all markets and then to markets within each size group.

A high linear relationship was found to exist both for all markets combined and within the specific size groups, Table 25. The magnitude of the coefficients within size groups, however, suggests that the overall relationship may be non-linear in nature. That is, costs increase with volume but at a decreasing rate. If total costs respond either linearly or at a decreasing rate to changes in volume, the average cost function should be non-linear, decreasing at a decreasing rate as volume increases.

TABLE 27. ANALYSIS OF VARIANCE OF REGRESSION MODEL 1

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | 1.17001 | | |
| Due to regression | 2 | .88024 | .44012 | 13.66** |
| Error | 9 | .28985 | .03221 | |

TABLE 28. ANALYSIS OF VARIANCE OF REGRESSION, MODEL 2

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | 1.17001 | | |
| Due to regression | 1 | .82306 | .82306 | 23.71** |
| Error | 10 | .34703 | .03470 | |

To derive average cost curves, four non-linear statistical models were postulated:

$$Y = A + b_1X_1 + b_2X_2 \qquad \text{(Model 1)}$$

$$Y = A + b_1\left(\frac{1}{X_1}\right) \qquad \text{(Model 2)}$$

$$\log Y = A + b_1 \log X_1 \qquad \text{(Model 3)}$$

$$Y = A + b_1\left(\frac{1}{X_1}\right) + b_2\left(\frac{1}{X_2}\right) \qquad \text{(Model 4)}$$

where Y is cost per marketing animal unit, $X_1$ is the number of animal units handled and $X_2$ is the squared value of $X_1$.

Each of these models was tested against variable, fixed and total costs of individual firms. However, the extreme variability in reported costs among firms in the lower output ranges prevented the development of logically consistent relationships. This type of analysis is extremely sensitive to data variation at these lower output ranges.

To reduce the effect of inter-firm variation, markets were combined into a number of size-based categories, and average cost and volume figures were used as the regression inputs, Table 26.

Each of the four statistical models was used to fit regression equations to average total cost per unit and market volume. The equations and their tests of significance follow. The standard deviation appropriate to each coefficient of regression is directly below that coefficient. Both the coefficient of determination ($R^2$) and the standard error of estimate (S.E.) are shown for each regression equation.

Model 1, Table 27.

$$Y = 2.50 - .1362^{-4}X_1 + .4354^{-10}X_2$$
$$\text{Sd} = .39^{-5} \quad \text{Sd} = .19^{-10}$$

$R^2 = .75$ S.E. = .170

Model 2, Table 28.

$$Y = 1.72 + 7.4946\left(\frac{1}{X_1}\right)$$
$$\text{Sd} = 1.53$$

$R^2 = .77$ S.E. = .145

TABLE 29. ANALYSIS OF VARIANCE OF REGRESSION, MODEL 3

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | .05607 | | |
| Due to regression | 1 | .04527 | .04527 | 41.92** |
| Error | 10 | .01080 | .00108 | |

TABLE 30. STEP-UP ANALYSIS OF VARIANCE OF REGRESSION MODEL 4

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | 1.17001 | | |
| Due to significant variable | 1 | .82306 | .82306 | 23.71** |
| Error | 10 | .34703 | .03470 | |
| Due to squared variable | 1 | .07361 | .07361 | 2.42 N.S. |
| Error | 9 | .27343 | .03038 | |

Model 3, Table 29.

$$\log Y = 1.06 - .1667 \log X_1$$
$$\text{Sd} = .026$$

$R^2 = .81$ S.E. = .032

Model 4, Table 30.

As originally constructed, Model 4 yielded an ill-conditioned matrix because of the lack of sufficient significant numbers from the reciprocal of squared volume data. To correct this deficiency, the second independent variable was converted to a more reasonable size base by multiplying the reciprocal value by 1,000 to yield the following regression form.

$$Y = A + b_1\left(\frac{1}{X_1}\right) + b_2\left(\frac{1}{X_2}\right)1{,}000$$

The regression equation then became:

$$Y = 1.58 + 15.1167\left(\frac{1}{X_1}\right) - 55.3818\left(\frac{1}{X_2}\right)1{,}000$$
$$\text{Sd} = 5.104 \qquad \text{Sd} = 35.579$$

$R^2 = .76$

However, the analysis was programed to reject any independent variable at the t.05 level. The contribution to the reduction in sum of squares by the squared variable was not statistically significant, Table 30. Consequently, this variable was rejected,

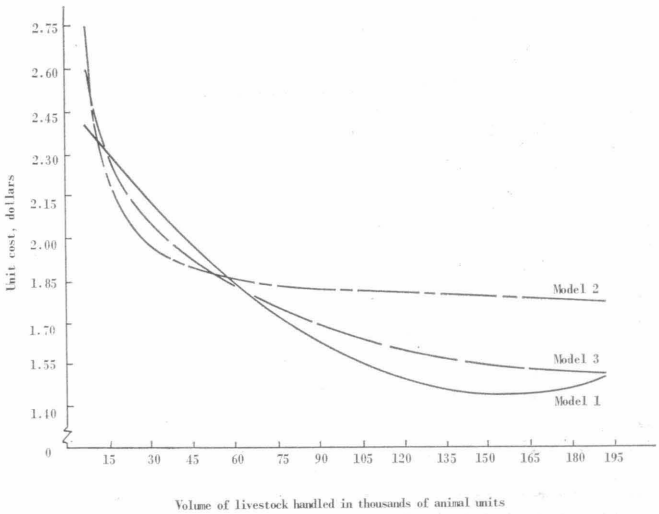


Figure 3. Relationship between cost per animal unit and volume handled for three regression models.

TABLE 31. ANALYSIS OF VARIANCE OF REGRESSION, MODEL 2, APPLIED TO AVERAGE VARIABLE COSTS

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | .40149 | | |
| Due to regression | 1 | .32007 | .32007 | 39.31** |
| Error | 10 | .08142 | .00814 | |

TABLE 32. ANALYSIS OF VARIANCE OF REGRESSION, MODEL 2, APPLIED TO AVERAGE FIXED COSTS

| Source | D.F. | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Total | 11 | .22809 | | |
| Due to regression | 1 | .11661 | .11661 | 10.46** |
| Error | 10 | .11148 | .01115 | |

and the equation reverted to the same form as Model 2. For that reason, this model was not used in the remainder of the analysis.

The application of the three remaining models to average total costs is shown in Figure 3. All three models are statistically significant at the 1 percent level. Although a greater percentage of the variation in cost has been explained by Model 3, the difference in the proportion of the variation in cost accounted for by the three models is not great. From this standpoint, there is little reason to choose one model over the others.

Model 1, which is the model perhaps most consistent with economic theory, describes an average cost curve that decreases at a decreasing rate, reaches a bottom and then increases at an increasing rate within the observed data range. This model describes a condition that might exist if data were available for firms of considerably greater size. However, within the range of sizes observed here, average costs have not reached the increasing stage. For that reason Model 1 was not considered the model best suited to the data.

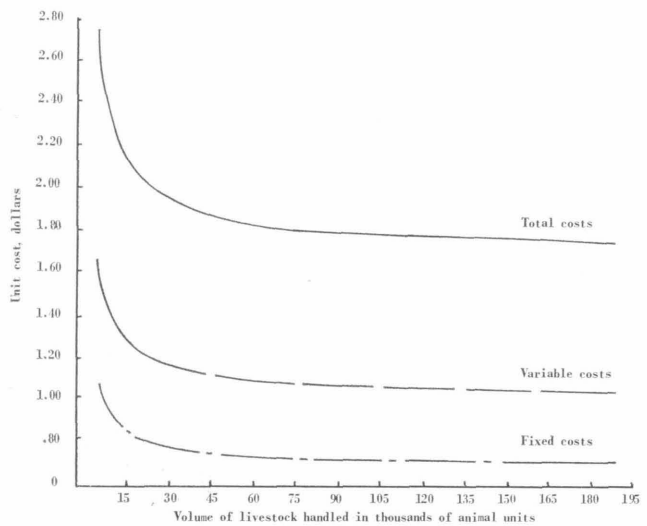


Figure 4. Planning curves for Texas auctions.

Models 2 and 3 have a similar characteristic; they tend to flatten out or become asymptotic as they approach zero but never reverse their slope. To that extent, they both appear consistent with the data in the ranges observed. Of the two models, however, Model 2 appears to best describe the data at the two ends of the output range and has the lower standard error of estimate. Model 3 tends to underestimate costs at both the very low and very high output ranges. Although considered the best fit, Model 2 tends to overestimate costs slightly at the higher output ranges.

Applying Model 2 to fixed and variable costs yields the following regression equations:

Variable costs

$$Y = 1.03 + 4.6737\left(\frac{1}{X_1}\right)$$

$$Sd = .7454$$

$R^2 = .80$ S.E. = .090

Fixed costs

$$Y = .70 + 2.8210\left(\frac{1}{X_1}\right)$$

$$Sd = .87$$

$R^2 = .52$ S.E. = .105

From these estimating equations, the planning curves shown in Figure 4 were developed to show the contributions of fixed and variable costs to average total costs for Texas auctions. It can be seen from these curves that cost economies are greatest as volumes are increased from levels below 20,000. As volumes approach 40,000 animal units, cost economies are rapidly dissipated as the average cost curve begins to flatten out noticeably. On the basis of these relationships, it would appear that volume levels of at least 20,000 animal units annually would be an absolute minimum goal of auction operators and that every effort should be made to expand volume to a practical minimum of 40,000 units to take advantage of economies inherent in larger size operations.